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ELECTRIC POWER DEVELOPMENT IN THE UNITED STATES

LETTER

FROM THE

SECRETARY OF AGRICULTURE

TRANSMITTING

A REPORT, IN RESPONSE TO A SENATE RESOLUTION OF FEBRU-
ARY 13, 1915, AS TO THE OWNERSHIP AND CON-
TROL OF THE WATER-POWER SITES
IN THE UNITED STATES

IN THREE PARTS

PART 1



JANUARY 20, 1916.—Referred to the Committee on Printing

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ERRATA - PART I

Page 25 - Scale of Plate IV should be 50, 100, 150, etc., instead of 5, 10, 15, etc., as printed.

Page 26 - Legend of Plate V should be "Manufactures", "Central Stations", "Electric Railways" instead of "1912", "1907", "1902" as printed.

The following changes are made necessary on account of a duplication of 25,000 horsepower in the figures as originally reported for Minnesota. Totals for the State and for the United States will be reduced by the above amount and percentages as appearing on pages 56, 58, 59, 60, 61 and 62 will be changed by about one-tenth of one per cent as follows:

Page 56 - Minnesota. Line 1, for 89.9 read 88.8; line 2, for 82.2 read 81.1; line 3, for 71.9 read 68.9; line 4, for 65.4 read 63.1; line 5, for "one-half of 1" read 0.6; line 6, for 5.7 read 6.0.

Page 58 - United States. Line 8, for 3,521,423 read 3,496,423; line 10, for 9,796,515 read 9,771,515, and for 65.9 read 65.8; line 15, for 68.6 read 68.5; line 20, for 65.9 read 65.7; line 24, for 72.3 read 72.2.

Page 59 - Line 2, for 51.1 read 51.4; line 5, for 33.7 read 33.9; line 6, for 25.3 read 25.4.

Page 60 - William P. Bonbright & Co. Line 5, for 19.2 read 19.3.
E. W. Clark & Co. Management Corporation. Line 15, for 18.3 read 18.4.

Page 61 - Electric Bond & Share Co. Line 10, for 20.1 read 20.2.
General Electric Company. Line 11, for 15.2 read 15.3; line 12, for 14.3 read 14.4; line 29, for 28 read 28.1, and for 21.3 read 21.4.
Electrical Utilities Co. Line 6, for 18.8 read 18.9.
Federal Utilities (Inc.) Line 12, for 19.8 in each class read water power, 19.9 per cent, steam power 19.8 per cent, and total power 19.8 per cent.

Middle West Utilities Co. Line 9, for 19.8 per cent in each class read water power, 10.5 per cent; steam power, 10.3 per cent; total power, 10.3 per cent.

North American Co. Line 9, for 10.8 read 10.9; line 11, for 8.9 read 9.0.

Stone & Webster Management Association. Line 8, for 29.4 read 29.5.

United Equities Corporation. Line 9, for 20.8 read 20.9.

Page 62 - J. H. White & Co. (Inc.) Line 7, for 17.7 read 17.8.

ELECTRIC POWER DEVELOPMENT IN THE UNITED STATES

LETTER

FROM THE

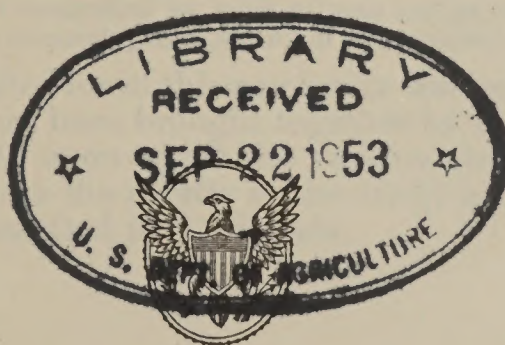
SECRETARY OF AGRICULTURE

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SECRETARY OF AGRICULTURE

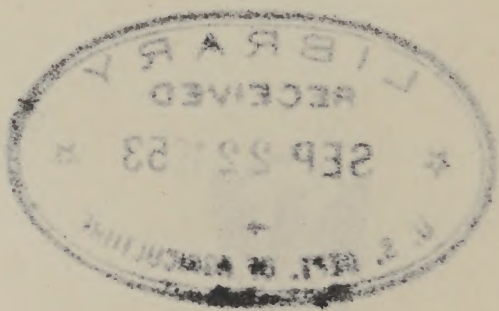
REPORTED BY MR. FLETCHER.

IN THE SENATE OF THE UNITED STATES,
February 8, 1916.

Resolved, That the report entitled "Electric power development in the United States and concentration in its ownership and control," transmitted to the Senate by the Secretary of Agriculture on January 20, 1916, in response to Senate resolution No. 544, Sixty-third Congress, be printed as a Senate document, together with accompanying tables and illustrations: *Provided*, That Part I of said report be first printed and furnished to the Senate at the earliest practicable day.

Attest:

JAMES M. BAKER, *Secretary*.



LETTERS OF TRANSMITTAL.

DEPARTMENT OF AGRICULTURE,
Washington, January 17, 1916.

SIR: In accordance with the provisions of Senate resolution No. 544, passed by the Sixty-third Congress, third session, I have the honor to transmit herewith the information in my possession as to the ownership and control of the water-power sites in the United States; showing what proportion of such water-power sites is in private ownership and by what companies and corporations such sites in private ownership are owned and controlled; what horsepower has been developed and what proportion of it is owned and controlled by such private companies and corporations; and facts bearing upon the question as to the existence of a monopoly in the ownership and control of hydroelectric power in the United States.

Respectfully,

D. F. HOUSTON, *Secretary.*

The PRESIDENT OF THE SENATE.

DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, December 21, 1915.

The SECRETARY OF AGRICULTURE.

DEAR MR. SECRETARY: Senate resolution No. 544, passed by the Sixty-third Congress, third session, directed that the Secretary of Agriculture furnish to the Senate certain information in regard to the water-power industry. The resolution reads as follows:

Resolved, That the Secretary of Agriculture be, and he is hereby, directed to furnish the Senate with all information in his possession as to the ownership and control of the water-power sites in the United States, showing what proportion of such water-power sites is in private ownership and by what companies and corporations such sites in private ownership are owned and controlled, what horsepower has been developed, and what proportion of it is owned and controlled by such private companies and corporations, and any facts bearing upon the question as to the existence of a monopoly in the ownership and control of hydroelectric power in the United States.

The work of preparing the material called for in this resolution was assigned to Mr. O. C. Merrill, chief engineer of the Forest Service. The information has been brought together by Mr. Merrill in the form of a report which contains, in addition to the text, the data upon which the various conclusions are based. There are, further, various charts and diagrams which illustrate the results of the study in graphic form.

I recommend that this report be transmitted to the Senate.

Very sincerely, yours,

H. S. GRAVES, *Forester.*

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LETTER OF SUBMITTAL.

DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, December 20, 1915.

SIR: I submit to you herewith a report upon Electric Power Development in the United States and the Movement Toward Concentration of Control, prepared in response to Senate resolution 544, Sixty-third Congress, third session.

This report has been made up from data which have been accumulating for several years in the office of the chief engineer, supplemented by investigations made in the field by district engineers of the Forest Service and by correspondence with officials of power companies, to whom have been submitted for verification the greater part of the data on power development in 1915 as contained in the report.

The report is presented in three parts: Part I, containing the text of the report; Part II, the plates and tables concerning primary power, power generated, and financial statistics, the detailed data of power developments in 1915, the summary tables showing the concentration in control of this power, and maps of fourteen of the public-land States showing the location of all power plants, main transmission systems, and national-forest areas; and Part III, which contains the data concerning the interrelations between public-service holding companies and the relation of these companies to certain banking corporations, diagrams showing the successive steps by which certain holding companies have established their control over operating companies, and charts indicating the relation through directors or principal officers of certain public-utility holding companies with each other.

In submitting this report I wish to express my appreciation of the invaluable assistance given by Mr. T. W. Norcross, assistant chief engineer, who, together with Mr. Frank A. Law, of the Portland office, collected the data and prepared the tables and charts in Part III of the report; by Mr. J. P. Martin, district engineer of the Ogden office, who made the special census of electric power development for 1915; and by Mr. Ralph R. Randell, assistant engineer, who aided in the preparation of all parts of the report, and especially in the computation of the tables and plates of Part II.

Respectfully,

H. S. GRAVES, *Forester.*

O. C. MERRILL,
Chief Engineer.

REPORT ON ELECTRIC POWER DEVELOPMENT IN THE UNITED STATES AND CONCENTRATION IN ITS OWNERSHIP AND CONTROL.

Part I. Text of report.

Part II. Potential power resources of the United States; Comparative statistics of primary power, power generated, and finances for 1902, 1907, and 1912; Electric power census for 1915, and statistics of concentration of control; Tables, maps, and diagrams.

Part III. Consolidation of electric power holding companies, and interrelations through common directors or principal officers of such companies with each other and with certain banking corporations; Tables and charts.

PART I.

INTRODUCTION.

This report has been prepared in response to Senate resolution No. 544, Sixty-third Congress, third session, which is as follows:

Resolved, That the Secretary of Agriculture be, and he is hereby, directed to furnish the Senate with all information in his possession as to the ownership and control of the water-power sites in the United States, showing what proportion of such water-power sites is in private ownership and by what companies and corporations such sites in private ownership are owned and controlled; what horsepower has been developed and what proportion of it is owned and controlled by such private companies and corporations; and any facts bearing upon the question as to the existence of a monopoly in the ownership and control of hydroelectric power in the United States.

The report deals with the amount of developed power in all the States, whether water power, steam power, or gas power, and whether developed by public-service corporations, by industrial corporations, or by municipalities. The inquiry has been made thus extensive because only by such means can a clear understanding be had of the relation of water-power development to general power development and of the movement toward concentration of control in the electric-power industry. Complete data are given for the years 1902, 1907, and 1912, and data of public-service electric development and of the larger industrial water powers for 1915. The former are taken from the reports of the Bureau of the Census, the latter were obtained by a special census made in connection with this report.

Studies have been made of the amount of power generated and of the financial operations of commercial and municipal stations for the three census years. The investigations concerning concentration in the ownership and direct control of electric power in general, and of water power in particular, are from 1915 data.

In the investigation of the relationship of electric power corporations to each other and to banking corporations through common directors and principal officers it was necessary to use data for 1914. In connection with this line of investigation there is presented in Part III a list of some 1,500 electric power holding and operating companies, showing for

each the corporations with which it is affiliated through common directors or principal officers, and a list of such officers and directors, giving with each the company in which he serves.

On account of the oft-repeated assertion that in the Western (or public-land) States power development has become stagnant because of the lack of appropriate legislation, specific attention has been directed toward determining whether this assertion has any foundation in fact.

In order that anyone who may not agree with the conclusions reached in this report may have the information from which to draw his own independent conclusions, the entire data upon which the report is based are presented in detail in Part II and Part III.

RÉSUMÉ OF THE REPORT.

POTENTIAL WATER-POWER RESOURCES OF THE UNITED STATES.

The most comprehensive estimates of the water-power resources of the United States are those which were made by the United States Geological Survey in 1908 for the National Conservation Commission. In connection with this report, the survey's original estimates have been reviewed in detail for the Western States, the entire estimate compared with the revised figures as presented by the Commissioner of Corporations in his report on "Water-power development in the United States," 1912, and corrections made for certain omissions. Segregation has been made of that part of the estimated power which is located on the national forests, both minimum and maximum, according to the basis used by the survey with reduction to a plant efficiency of 75 per cent. The minimum estimates represent the amount of power that could be developed from the use of the average annual minimum stream flow "for the lowest two consecutive seven-day periods in each year." The maximum represents the amount that could be developed from the use of the average maximum continuous stream flow available for six months during the year. On these

two bases the figures as corrected and computed at 75 per cent efficiency give the minimum potential water-power resources as 27,943,000 horsepower, and the maximum as 53,905,000 horsepower. Of these amounts the national forests contain a minimum of 8,497,600 horsepower, or 30.4 per cent of the total minimum; and a maximum of 16,874,500 horsepower, or 31.3 per cent of the total maximum for the United States.

The most significant fact in connection with these figures is the geographical concentration of water powers. Of the estimated total for the United States over 72 per cent is found in the Mountain and Pacific States—the public-land States. Nearly one-half of the total, or 42 per cent, is found in the three States Washington, Oregon, and California. Of the water powers within the national forests, 99 $\frac{3}{4}$ per cent are found in the Western States, and these powers amount to 42 per cent of the minimum and 43 per cent of the maximum estimated power resources of those States.

DEVELOPED POWER IN THE UNITED STATES.

The total primary power under development in the United States in 1912 in commercial and municipal central stations, street and electric railways, and in manufacturing plants as estimated and reported for the year was 30,448,246 horsepower. Twenty-two and nine-tenths per cent of this amount was used in commercial central stations—the public-utility business. Municipal stations had 1.8 per cent and electric railways 12.1 per cent. Nearly two-thirds of the total, or 63.2 per cent, was used in manufactures.

Sixteen per cent of the total primary power in 1912, or 4,870,320 horsepower, was water power, of which nearly one-half was used in commercial central stations. Municipal stations had less than 3 per cent, street and electric railways about 10 per cent, and manufactures about 40 per cent. The proportion of water power which is used in public-service operations is more than twice as great as the proportion of other sources of power.

The reported and estimated steam installation for the United States in 1912 was 24,339,819 horsepower, 80 per cent of the total power from all sources. Two-thirds of the steam power was used in manufacturing, about one-fifth in commercial central stations, one-eighth in street and electric railways, and less than 2 per cent in municipal stations. The three States Pennsylvania, New York, and Ohio had more than one-third of the total steam power installation of the United States. Internal-combustion engines are a relatively unimportant source of primary power, their installation amounting to only 4 per cent of the total from all sources in 1912, 90 per cent of which was used in manufactures.

PRIMARY POWER IN PUBLIC-SERVICE OPERATIONS.

The clearest understanding of the trend of electric power development can be had from a consideration of the primary power installations of the commercial and municipal central stations and the street and electric railways, for these classes of uses comprise the electric power industry. The total primary power installed in these classes of stations in 1912 aggregated 11,193,699 horsepower, 36.8 per cent of the total primary power used for all purposes in the United States. Slightly over one-fourth of the total was water power

and nearly three-fourths steam power. The preponderance of steam power is mainly found in the Eastern States where two groups, the Middle Atlantic and the East North Central States had in 1912 more than one-half the total for the United States. The special census of public-utility plants made for this report shows an increase of 2,769,036 horsepower since 1912, of which 1,668,114 horsepower is water power and 1,100,922 horsepower steam power. The rate of increase in water-power development during these last three years for public-service use has been three times as great as the rate of increase in steam power.

MUNICIPAL POWER DEVELOPMENT.

Municipal stations in 1912 had 559,328 horsepower of primary installation, or less than 2 per cent of the total from all sources and for all uses in the United States, and about 8 per cent of the amount installed in commercial central stations. The upper Mississippi Valley leads in municipal development, although Washington had in 1912 the largest installation of any single State. The highest rate of increase in municipal development is found in the Western States, the Mountain group increasing 1,960 per cent and the Pacific group 2,280 per cent from 1902 to 1912.

RELATION OF WATER-POWER DEVELOPMENT TO TOTAL POWER DEVELOPMENT.

In seven of the nine geographic divisions—the Pacific and Mountain groups alone excepted—the total primary power installed in 1912 was in excess of the estimated minimum potential water-power resources of the section, and in five out of the seven in excess of the maximum resources without storage. Five great groups of States, the New England, the Middle Atlantic, the East North Central, the West North Central, and the West South Central, having in 1912 a population of 67,000,000, or 70 per cent of the total for the United States, had already installed a primary power equipment, water, steam, and gas, of 14 $\frac{1}{2}$ million horsepower, or 171 per cent in excess of their estimated maximum water-power resources; and two other groups, the South Atlantic and the East South Central, had exceeded their minimum resources. In these seven groups 23 individual States had already installed in 1912 primary power equipment in excess of their maximum water-power resources and 29 States in excess of their minimum resources. Under such circumstances it is idle to assume that water power can wholly supersede steam power over the greater part of the United States under any conditions now known. While it would be rash to attempt to predict the future or to set limits to the distance to which it may be possible eventually to transmit electric power, yet until the time shall have come, if it ever comes, when the enormous power resources of the Western States can be developed and transmitted into the States of the Mississippi Valley and along the Atlantic coast, the greater part of the United States will be forced to rely for the larger part of its power on sources other than water power.

RELATIVE POSITION OF THE WESTERN STATES IN PRIMARY POWER DEVELOPMENT.

In the eleven Western States included within the Pacific and Mountain groups, primary power installation from all sources and for all uses increased 240 per

cent from 1902 to 1912, or more than two and a half times as rapidly as in the remainder of the United States. In primary power equipment per capita the Western States during the same period added nearly twice as much to their total installation as the remainder of the United States and had an installation at the end of the period one-third greater than for the remainder of the United States. This comparison includes primary power used directly in manufactures, 94 per cent of which is found in the Central and Eastern States.

If a comparison is made of the development of electric power in the Western States and the remainder of the United States it is found that while primary power employed in the electrical industry increased 226 per cent in the remainder of the United States in the 10 years 1902 to 1912, it increased 440 per cent in the Western States, or nearly twice as rapidly, while the development per capita in the Western States in 1912 was two and a half times as great as in the remainder of the United States.

If water power be considered apart from all other sources of power, the Western States are found to occupy a still more commanding position. While water-power development in the remainder of the United States increased 98 per cent from 1902 to 1912, it increased 451 per cent in the Western States, or more than four and a half times as rapidly. In installed water power per capita the Western States in 1912 had more than four times as much as the remainder of the United States.

An examination of the data collected since the census of 1912 shows that the Western States are still maintaining their commanding position in power development. Primary power installation in the electrical industry in the Western States has increased nearly 47 per cent in the three years since 1912. The average annual increase has been 296,000 horsepower, as compared with 191,000 for the five years 1907 to 1912. Three-fourths of the total increase is water power, in which the average annual additions for the last three years have been approximately twice as great as the average for the preceding five years.

While the use of electric power for all purposes except manufactures is greater in the Western States than in any other section of the country, and this greater use explains in large degree the extent of primary power installation, there is also at the present time a considerable overdevelopment in nearly all the power centers of the Western States. California, Oregon, and Washington in particular show installations far in excess of maximum demands. While there are doubtless many remote sections where small amounts of power could be used if it could be supplied at a reasonable expense, the Western States in general have more power at the present time than they are able to dispose of and the real demand is for more markets rather than for more power.

FINANCIAL OPERATIONS OF CENTRAL STATIONS.

The total investment in commercial central stations in the United States in 1912 as represented by the reported cost of construction for the year was over \$2,000,000,000, equivalent to \$21.97 per capita and to an average of \$301 per horsepower of primary power installation. In marked contrast to these figures are those for municipal stations, which report an aggre-

gate cost of 77 millions and a cost per horsepower installed of \$138, less than one-half of the reported cost of commercial stations.¹ While municipal accounting may often fail to include all the items of expense properly chargeable against its undertakings, it is not probable that any considerable part of the difference shown can be explained on this ground. It is very doubtful if amounts reported by commercial stations as "cost of construction, equipment, and real estate" represent actual cost at all in the sense of cash expenditures or their equivalent. Costs in this sense have rarely been kept except in recent years in a few States under the pressure of public-utility legislation. Furthermore, it appears to be the general practice of public-utility corporations to denominate as "cost of construction" the amount which will make assets equal to liabilities on their balance sheets. Since stocks and bonds are carried on such balance sheets at par, the so-called "cost of construction" is scarcely more than net capitalization. In the majority of cases it would be more nearly correct to call this item "assumed present value of properties" than to call it "investment in" or "cost of" such properties.

The funded debts of both municipal and commercial stations bear approximately the same relation to the reported cost of construction for each class of stations; but when it is considered that the reported cost of construction of commercial stations is more than twice as great per horsepower as for municipal stations, it would appear that the latter have been more conservatively financed.

The average rate of interest paid upon funded and floating debt by commercial stations in 1912 was 4.52 per cent. The total par value of outstanding common and preferred stocks of commercial central stations in the same year was approximately \$1,100,000,000.² Upon this amount the surplus income, after the payment of all expenses, including depreciation, interest on the funded and floating debt, and sinking-fund charges, was sufficient to have paid a dividend of 5.58 per cent.³ The dividends reported to the Bureau of the Census as having actually been paid upon both classes of stock in 1912 amounted to an average of 3.15 per cent upon the par value of approximately \$1,100,000,000.² The fact that dividends may not be paid in any year or on any particular property is not necessarily an indication of the prosperity of the business. It is a common practice to utilize surplus earnings which might be available for dividends in extensions to plant, allowing the stockholders to receive their profits not in a cash payment but in an increase in the equity in the property.

The total par value of outstanding common and preferred stock in the 11 Western States in 1912 was approximately \$360,000,000.² Upon this amount the surplus income was sufficient to have paid a dividend of 2.35 per cent, or less than one-half the average for the United States; but on the other hand, the outstanding stock per horsepower in the Western States was nearly twice as great as for the United States as a whole.

In total reported cost of construction up to 1912, the Middle Atlantic States alone exceed the Pacific States. In actual increase for the period from 1902

¹ See Central Electric Light and Power Stations and Street and Electric Railways, 1912, Bureau of the Census, pp. 64 and 72.

² This figure assumes that intercompany holdings are half bonds and half stock. The precise figure is indeterminable because intercompany holdings of stocks and bonds were not reported separately.

³ See p. 50.

to 1912, a Western State, California, with an increase of 308 million dollars leads all other States by more than 70 million dollars. Only five other States increased as much for the five years, 1907 to 1912, as the State of California for each year of the period. The average rate of increase in plant investment, or cost, of commercial stations in the Western States from 1902 to 1912 was nearly three times as great as for the remainder of the United States, while the investment per capita in 1912 was four and one-half times as great as for the remainder of the United States.

The higher reported cost, higher capitalization, and higher funded debt per primary horsepower in the Western States may be partially explained by the greater proportion of water-power development at considerable distances from the markets supplied and the large investments required for the extensive transmission systems which are such a prominent feature of western power development.

POWER DEVELOPMENT ON THE PUBLIC LANDS.

Of the 1,800,000 water horsepower developed in the Western States in 1915, 30 per cent is in plants occupying national forest lands with some part—power house, water conduit, or diversion reservoirs—of the immediate generating plant. Twelve per cent more are directly dependent upon storage reservoirs owned by the operating companies or by their subsidiaries, and constructed on national forest lands. The total of power developments thus utilizing national forest lands amounts to 42 per cent of the total developed power of the Western States. Nearly 14 per cent in addition either occupies public lands outside the national forest or is directly dependent upon storage reservoirs constructed upon such lands. Fifty-six per cent, therefore, of the total developed water power of the Western States either occupies or is directly dependent upon the use of public lands of the United States, as such occupancy and use is authorized under existing law.

In addition to the operating plants, there are now under construction on the national forests hydroelectric plants with an estimated capacity at minimum stream discharge of 123,000 horsepower. Outstanding final permits authorizing the occupancy and use of national forest lands for hydroelectric plants, the construction of which has not yet started, aggregate 420,000 horsepower, and preliminary permits, maintaining the priority of applicants while surveys and investigations are being conducted, aggregate 354,000 horsepower.

ELECTRIC POWER GENERATED.

Electric power plants supply a service, not a commodity. Since no economic method has yet been devised for storing electric energy in large quantities, electric power generation must be coincident with the demand and vary according to the demand. Every power plant must not only have an installation sufficient to meet the maximum demands, but also must have a certain percentage of excess installation for the purpose of anticipating increase in markets and to insure continuity of service in case of accident. The relation between the average rate and the maximum rate at which power is generated during any given period of time is known as the "load factor" for that period. While the census reports give data by which the average rate may be determined they do not give

"peak" demands. It is not possible, therefore, to determine for the United States as a whole or for the several States this "load factor" ratio. Since, however, the census reports do give the installed capacities of the generators, the relation between the average rate of power generation and the generator installation, known as the "capacity load factor," may be determined. This factor for 1912 averaged 0.262 for the United States. If based upon primary power installation instead of generator capacity the average ratio would be 0.241. This means that, on the average, the primary power installed in all these stations was utilized to only 24 per cent of its full capacity.

This capacity load factor, or ratio of utilization of installation, is of greatest importance in the electrical power business. Certain charges upon a power plant, such as interest, insurance, and taxes, and to a considerable degree depreciation, are constant regardless of the amount of the output. Even operating charges become less per unit of output as the output increases. Every means which may be employed to increase the percentage of utilization increases the profits of the business. Different classes of users have different times of maximum demand. The larger the market supplied the greater this diversity. To secure the advantages attendant upon diversity of demand is one of the chief reasons for joining many plants and many markets into one combined system.

CONCENTRATION IN CONTROL OF DEVELOPED POWER.

The concentration in control of electric power is evidenced both by the increase in the amount held by public-service corporations as a class and in the amounts which are held by certain corporations in particular.

Of all the primary power employed in the electrical industries and in manufactures in 1902, 11.2 per cent was installed in commercial central stations. This proportion had risen to 23.8 per cent in 1912, more than doubling in the 10 years. The movement toward concentration is found in all sections of the United States. For the 10 years 1902 to 1912 the rate of concentration was highest in the South Atlantic States, which had three times as great a proportion of primary power in commercial stations in 1912 as in 1902. The extent of concentration was greatest in the Western States. Fifty per cent of all primary power of all kinds in the Mountain States in 1912 was owned by public-service corporations; 54 per cent in the Pacific States. In California the proportion was three-fourths. To-day, only three years later, public-service corporations own 90 per cent of all the primary power in these two groups of States. Although the 1915 data are not sufficiently complete in the other sections, particularly concerning power used in manufactures, to give definite percentages, it is probable that in the South Atlantic States the percentage of power owned by public-utility companies is well above 50 per cent, as compared with less than 20 per cent in 1912.

If inquiry is made into the control by certain corporations, it is found that 85 public-service corporations, through ownership of properties, majority ownership of stock, lease, or direct management, control 68.6 per cent of the total public-service power in the United States; 35 of these 85 control one-half of the total; 16 control one-third; and 10 control one-fourth. Of these 85 corporations, 59 have water-power developments; and of these 59, 18 control 2,356,521 water

horsepower, or more than one-half of the total water power used in public-service operations in the United States. Of these 18 corporations, 9 control more than one-third of the total, and 6 more than one-fourth.

The character of control which is considered with reference to the above figures is definite and complete. It consists either of actual ownership of properties, of majority ownership of stock, of lease, or of direct management.

INTERCORPORATE RELATIONS THROUGH COMMON DIRECTORS.

In connection with this report a study has been made of the interrelations of various public-utility electric corporations with each other through common directors and principal officers. It is extremely difficult to correlate the mass of information and to determine in many instances whether a particular company has the closer association with one or another group of interests. For the purpose of showing the relationships that exist between 156 of the principal holding, managing, and operating companies, 16 charts have been prepared and are presented in Part III of the report. The individual companies which make up the 16 groups control 2,226,000 waterhorse power, or 48.3 per cent of the total used in public-service operations (commercial and municipal central stations and street and electric railways) in the United States, as indicated by the special census made for this report. They also control 4,160,000 steam horsepower or 44.5 per cent

of the total used in such public-service operations, giving a combined total of 6,386,000 horsepower, or 45 per cent of all the public-service power in the United States in 1915.

In contradistinction to the corporate relationships shown through ownership, lease, or management, by means of which the connection is definite and direct, the interrelations which are evidenced by common directors are indefinite, and the extent of control can not be quantitatively determined except in those instances where a majority of the directorate is common to two corporations. Where the preceding data show accomplished control, these data show potential control, a marked tendency toward association or community of interests, particularly between the principal holding companies, that can not be viewed without concern.

CONTROL OF UNDEVELOPED WATER POWER.

Time has not been available to make a detailed study of the control of undeveloped water power or to verify the information which has been collected in connection with other branches of inquiry. Such data as have been secured, however, show that 120 public-service corporations out of some 1,500 corporations, the developments of which have been listed in this report, claim to own or control a total of 3,683,000 undeveloped water horsepower or 80 per cent of the total water power at present developed and used in public-service operations.

POTENTIAL POWER RESOURCES OF THE UNITED STATES.

No accurate knowledge is available concerning the potential water-power resources of the United States. Estimates varying from 20 million to 200 million horsepower have been made according to the assumptions on which the several estimates have been based. An accurate estimate of potential water powers would require long-term run-off records on all streams and detailed surveys of the stream channels in order that sufficiently reliable data of water supply might be available, and in order that sections of streams having too little gradient for practical development might be eliminated from consideration. Data of this character are now available on but few streams and probably will not be available for many years to come upon the majority even of those streams which possess considerable potential water power.

The only comprehensive survey of the water resources of the United States is that being conducted under the direction of the United States Geological Survey. The number of gauging stations that can be maintained is limited by the funds available for that purpose. On July 1 of the present year run-off records were being taken at 1,221 stations in the United States, or, on an average, at 1 station for each 2,400 square miles of area. Many of these stations have been too recently established to give reliable data for power estimates, while in large sections of the country, particularly in the mountain regions of the Western States, where the greatest power resources are found, no stations have yet been established. Under such conditions it is evident that estimates of the potential water-power resources of the United States must necessarily be only approximate.

Aside from the lack of available data, estimates will vary greatly according to the assumptions upon which they are made. One estimate may take into

consideration only those sites which appear to be economically available for use under present conditions of cost and of markets. Another may take into consideration the ultimate possibilities of the distant future when a demand will exist for all possible power regardless of cost of construction. Between these extremes any number of assumptions with correspondingly varying estimates of potential power may be made.

ESTIMATES OF THE UNITED STATES GEOLOGICAL SURVEY.

The most comprehensive attempt to estimate the power resources of the United States of which the writer has knowledge was that made in 1908 by the United States Geological Survey for the National Conservation Commission. Since these estimates are the ones most often quoted, a brief statement of the basis upon which they were made is of interest.

The approximate character of the estimates is frankly admitted in the opening statement of the report (Water-Supply Paper No. 234, p. 46), which says:

The surveys and examinations necessary to a thorough and accurate report of the water-power resources of the United States have never been completed. In certain parts of the country the facts are sufficiently well known to make it possible to present a tolerably accurate statement. In other parts the information is fragmentary and, therefore, power estimates must be considered approximate.

Proceeding to a discussion of the basis of the estimates, the report further states:

The schedule presented in this report gives the amount of available water power according to three classifications: (1) that which may be produced by the minimum flow; (2) the assumed maximum development; and (3) the additional power that may be recovered by developing the available storage capacity in the upland basins and using stored water to compensate the low-water periods. The data as a whole have been considered without reference to present practicability of development or present market. For the pur-

poses of this report it has been assumed that all the power in the United States will some day be required. Such an interpretation is the logical one when natural resources are being considered. In other words, the schedule here presented must be interpreted for the future rather than for the present. The reader should not assume that all the power here shown is economically available today. Much of it, indeed, would be too costly in development to render it of commercial importance under the present conditions of market and the price of fuel power. The schedule shows, therefore, what will be the maximum possibilities in the day when our fuel shall have become so exhausted that the price thereof for production of power is prohibitive, and the people of the country shall be driven to the use of all the water power that can reasonably be produced by the streams.

Consideration has been given to all the conditions that determine the possibilities of power production on the various rivers of the country.

Especially has the slope of the stream channels been scrutinized. Theoretically, of course, the energy developed by the various rivers is that produced by the total fall of the water from source to mouth, but it has not been assumed that, even under ideal conditions of market, all this power will ever be commercially available. The flatter portions of the river channels can never be profitably developed for power and they have not been included in the schedule. The rivers have been divided into sections of varying length, determined by channel slope, and the fall and flow of each section have been obtained from the best available source of information.

In determining the flow of the various sections the data of flow per square mile * * * have been applied. The drainage areas above the upper and the lower limits of each section have been determined and a mean taken for the whole section. This has been used as a factor along with the flow per square mile in determining the minimum flow for that section. This figure, together with 90 per cent of the total fall from head to foot, has been used to determine theoretical horsepowers, according to the usual formulas. It is obvious that in practice the entire fall along any stretch of river or at any power privilege can not be effectively utilized. In few places can even 90 per cent be utilized at the present time; but, inasmuch as these figures are supposed to cover future as well as present practice, and inasmuch as it may reasonably be assumed that future practice in water-power installation will improve, it is believed that 90 per cent of the fall along any particular power privilege or section may eventually be realized.

The results of calculations of theoretical power on 90 per cent total fall have been reduced 10 per cent to allow for the inefficiency of wheels. It is recognized that 90 per cent efficiency is too high to be used in calculations of power at the present time, 75 or 80 per cent being the usual installation maximum. Here, again, however, we are computing for future conditions as well as present ones, and it may confidently be expected that, with the improvement of turbines, a greater percentage of the theoretical power will be realized on the shaft and improvements will before long render possible a 90 per cent efficiency.

In determining the minimum horsepower, the minimum flow for the lowest two consecutive seven-day periods in each year was determined, and the mean of these values for the period of record was taken as the minimum flow. It is obvious that this is somewhat higher than the absolute minimum, but the latter is usually of so short duration that it does not equal the practicable minimum that may profitably be installed.

The assumed maximum economical development has been determined on the assumption that it is good commercial practice to develop wheel installation up to that amount the continuance of which can be assured during six months of the year, on the assumption that the deficiency in power during the remainder of the year can be profitably provided by the installation of fuel power plants as auxiliaries. In many parts of the country it has been shown conclusively that it is economical to develop up to that amount which can be had continuously during the highest four months of the year, and, while it is probable that there are parts of the country where the limit should be the highest eight or ten months, it is believed that the period used in these schedules is a very conservative average. The minimum weekly flow for each month of the year has been arranged according to magnitude, and the sixth value has been taken as the basis for estimating the power, the mean of these values for the record period in each case being that used in the computations.

Omitting storage from consideration, the final estimates, excluding Pennsylvania, for which figures were not available at the time of the report, and including a portion of the Rio Grande in Mexico and certain drainages in Canada, were a minimum of 36,916,250 horsepower and a maximum of 66,518,500 horsepower.

REPORT OF THE COMMISSIONER OF CORPORATIONS.

The Commissioner of Corporations in his report on Water Power Development in the United States made a review and correction of the survey's estimates. By deducting power not under the control of the United States, by adding amounts for Pennsylvania streams, and by making certain minor corrections, the survey's totals were reduced to 32,083,000 horsepower minimum and 61,678,000 horsepower maximum. The commissioner then says:¹

A further modification of these estimates should be made for the reason that they are based upon the assumption of 90 per cent efficiency power on the turbine shaft; that is, on the assumption that 90 per cent of the theoretical energy of the fall will be effective on the turbine shaft over and above losses in the head race and in the turbine itself. This is too high a basis. In fact, the Geological Survey admittedly made its estimates on the basis of probable future conditions of efficiency of hydraulic equipment.

It is absolutely certain, * * * that an efficiency of 90 per cent on the turbine shaft is at present too high. Many engineers base their estimates on 80 per cent; in fact, that figure may be said to be the conventional one. In actual practice, however, 75 per cent probably more nearly represents present possibilities than does one of 90 per cent, and this lower standard has been adopted in this report.

There is reason to regard these reduced totals as still too liberal for the potential water power of the country, because of the methods employed in computation. The computations are based on the flow and fall of streams.

In calculating the minimum flow of a stream it is the usual practice of engineers to select the minimum over a long period of years, notwithstanding the fact that water-power installations usually exceed the power indicated by such lowest-record flow.

The estimates for the minimum power, prepared by the Geological Survey, are not on the minimum flow for any day, or even on the lowest average for a very few consecutive days during the entire period covered, but are based on the averages of the minimum flow for the two lowest periods of seven consecutive days in each year for seven years or less, according to the length of the period for which records were available. It is obvious that such a minimum must be decidedly higher than the absolute minimum for a given day or the average for a smaller number of consecutive days. This fact was recognized in the estimate of the Geological Survey, but it was stated that the absolute minimum * * * is usually of so short duration that it does not equal the practicable minimum that may profitably be installed.

The "assumed maximum development" rests on quite a different basis. As estimated by the Geological Survey, it is based upon the continuous power indicated by the flow of a stream for the six months in the year (not necessarily six consecutive months) showing the highest flow. An average for six months yearly over a period of seven years was taken in all cases where records covering so long a period were available. The actual method was to arrange the months of each year according to the day of the lowest flow in each. The lowest of the six high months is taken as the basic month. The average flow of the lowest seven consecutive days in this month determines the maximum flow for that year. The average of such maximum figures for all years in the period for which data were available is the assumed maximum used in the calculation.

The potential water power estimated by the survey is undoubtedly further exaggerated by being based, in some cases at least, on 90 per cent of the total fall between two levels. * * * It is evident * * * that estimates of power based upon the total fall in a long section of a stream are likely to be far above what is practically available. Furthermore, a power development at one site frequently precludes the utilization of a considerable fall in the river above or below that site. What proportion of the theoretical power between two points several miles apart can be utilized can be determined only by an engineer's detailed examination.

From the data furnished by the Geological Survey there has been prepared in this bureau a table of this power by States. It should be emphasized that this rearrangement is more or less arbitrary. For example, in many cases the drainage basin of a river extends over several States, and it is difficult to allot the power possibilities of such a basin among the States involved. It is believed,

¹ See p. 51 of the Report of the Commissioner of Corporations, Mar. 4, 1912.

however, that the distribution made is reasonably accurate. The table shows the power as computed by the Geological Survey * * * on the basis of 75 per cent efficiency adopted by this bureau.

The statement of the Commissioner of Corporations above quoted that "in calculating the minimum flow of a stream it is the usual practice of engineers to select a minimum over a long period of years, notwithstanding the fact that water-power installations usually exceed the power indicated by such lowest flow," would have been more correct had he said "invariably exceed the power indicated by such lowest flow."

It is, in fact, the general practice, particularly in the larger power systems having several interconnected plants, to install hydraulic machinery capable of utilizing a stream flow not only far in excess of the absolute minimum, but also much in excess of the minimum as computed by the survey and to make up the deficiency with steam installation. What is known as the "base load" is carried by water power, with its high fixed charges and its low operating cost, while the daily and seasonal peaks are carried by steam power, with high operating charges and low fixed costs. This practice is especially prevalent in the Western States. The Nevada-California Power Co., for example, has developed plants on Bishop Creek to a point 75 per cent in excess of the minimum as computed by the survey. This degree of overdevelopment is made possible in part, though by no means entirely, by the use of certain storage reservoirs. The Southern California Edison Co., without storage facilities, has developed certain streams in southern California to nearly three times the minimum estimated by the survey method. It is probable that on the average western power developments are constructed to utilize not less than the average minimum of the nine high months of the year, an amount intermediate between the minimum and maximum estimates of the Geological Survey.

The relation for the several States between the minimum estimates of potential power and the aggregate installed water horsepower in 1912 may be seen by comparing Table No. 2 and Table No. 3, Part II. In six States—New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, and Delaware—the installed capacity of water wheels in 1912 was in excess of the estimated minimum potential power of the respective States, varying from one-fifth above the minimum in Delaware to nearly six times the minimum in Rhode Island. The installed capacity of water wheels in the six New England States exceeded by 22 per cent the Geological Survey's estimated minimum at 75 per cent efficiency. These instances serve to illustrate the conservativeness of estimates of potential power based upon minimum stream discharge.

CORRECTIONS FOR THE STATE OF IDAHO.

In his segregation of the figures (at 90 per cent efficiency) of the United States Geological Survey for the North Pacific drainage in Idaho, the Commissioner of Corporations, as appears in the tabulation on page 55 of his report, allotted to Idaho 1,394,000 horsepower minimum and 3,080,000 horsepower maximum. The figures, after segregation, were reduced to 75 per cent efficiency. An examination of the original summary sheets of the survey shows that the following amounts

were estimated for the several streams in the State of Idaho:

	Minimum.	Maximum.
	<i>Horsepower.</i>	<i>Horsepower.</i>
Snake River.....	1,400,000	2,900,000
Spokane River.....	50,000	100,000
Clarks Fork.....	10,000	20,000
Kootenai River.....	207,000	357,000
Total.....	1,667,000	3,377,000

A reduction of one-sixth in the above totals, in order to put them upon the basis of 75 per cent efficiency, would leave 1,389,000 horsepower minimum and 2,814,000 horsepower maximum instead of 1,162,000 horsepower minimum and 2,567,000 horsepower maximum as actually used by the Commissioner of Corporations. Furthermore, the survey's figures contained no estimates for water powers on the drainages of the St. Joe, Clearwater, Lochsa, Selway, and Salmon Rivers, the latter in particular being, next to the Snake, the most important power stream in the State. The omitted drainages contain, on the same basis as the other estimates and at 75 per cent efficiency, approximately 1,000,000 horsepower minimum and in excess of 2,000,000 horsepower maximum. To cover the Commissioner of Corporation's omission of survey estimates and the survey's omission of power on the five streams named, 1,200,000 horsepower minimum and 2,500,000 horsepower maximum has been added to the figures given by the Commissioner of Corporations, making the total for the State 2,362,000 horsepower minimum and 5,067,000 horsepower maximum. This correction will also change the totals for the United States to 27,943,000 horsepower minimum and 53,905,000 horsepower maximum. Amounts by States and by geographic divisions, using the figures of the Commissioner of Corporations, with corrections for Idaho, appear in Table No. 2, Part II.

RELATION OF ESTIMATES TO PROBABLE UTILIZATION UNDER PRESENT CONDITIONS.

By including all streams however remote from centers of population and those which would produce only a few hundred horsepower, and by including sections of navigable rivers having but slight gradient, the estimates, in general, cover many power sites which could not be developed under existing conditions of cost of construction and steam-power competition even if a demand existed within the limits of economical transmission. In so far as the minimum estimates are, on the other hand, based on an assumed stream discharge much less than it is customary to utilize in practice, the amount of power developed at any particular site will, in general, be greater than indicated by the minimum figures for that site and less than indicated by the maximum figures. Inasmuch as the figures given do not include increases made possible by use of storage—increases that can not be even approximately determined—the minimum figures probably underestimate the total that could be developed under existing conditions of cost and steam-power competition if a market were available. But whether the figures be too great or too small and by how much, they show with reasonable exactness the relative amounts of power in the several States and sections and indicate the magnitude of the potential power resources of the United States.

GEOGRAPHICAL CONCENTRATION OF POTENTIAL WATER POWER.

The most significant fact in connection with these figures is the geographical concentration of water powers. Of the estimated minimum for the entire United States, 72.3 per cent is found in the Mountain and Pacific States—the “public-land” States. More than half of this, or 41.2 per cent, is found in the three Pacific States of Washington, Oregon, and California. Totals and percentages by geographic divisions are as follows:

TABLE NO. 1.—*Estimated minimum and maximum potential water horsepower in the United States—Total and by geographic divisions.*

	Minimum.		Maximum.	
	Estimated horsepower.	Per cent.	Estimated horsepower.	Per cent.
New England.....	868,000	3.11	1,605,000	2.98
Middle Atlantic.....	1,357,000	4.86	2,488,000	4.62
East North Central.....	832,000	2.98	1,604,000	2.98
West North Central.....	902,000	3.23	1,956,000	3.63
South Atlantic.....	2,346,000	8.39	4,257,000	7.90
East South Central.....	1,087,000	3.89	1,964,000	3.64
West South Central.....	353,000	1.26	822,000	1.52
Mountain.....	8,694,000	31.11	16,131,000	29.92
Pacific.....	11,504,000	41.17	23,078,000	42.81
United States.....	27,943,000	100.00	53,905,000	100.00

Amounts and percentages for each State are given in Table No. 2, and are shown on plate 1, Part II.

POTENTIAL WATER-POWER RESOURCES OF THE NATIONAL FORESTS.

In connection with the review of the Geological Survey's figures on estimated water power an examination has been made of the original detailed estimates prepared by the district engineers of the survey in order to determine the amount of potential water power within the boundaries of the national forests in the several States. The estimates of the survey have also been supplemented by reports made by the district engineers of the Forest Service. Maximum and minimum figures have been computed upon the same basis as used by the survey and reductions have been made to the 75 per cent efficiency basis used by the Commissioner of Corporations. The totals thus found for the United States, exclusive of Alaska and of the purchased areas in the Appalachian, are 8,497,600 horsepower minimum and 16,874,500 horsepower maximum, or 30.4 per cent and 31.3 per cent, respectively, of the minimum and maximum for the United States. The

amounts and percentages by geographic divisions and the percentages which the power within the national forests bears to the total potential power for each geographic division are as follows:

TABLE NO. 2.—*Estimated minimum and maximum potential water horsepower in the national forests—Totals and by geographic divisions and the percentage relation of national-forest water powers to all water power in respective groups.*

	Minimum.		Maximum.		Per cent of total in each group.	
	Horse-power.	Per cent.	Horse-power.	Per cent.	Minimum.	Maximum.
New England.....	0	0	0	0	0	0
Middle Atlantic.....	0	0	0	0	0	0
East North Central.....	0	0	0	0	0	0
West North Central.....	12,900	0.15	26,300	0.16	1.43	1.34
South Atlantic.....	0	0	0	0	0	0
East South Central.....	0	0	0	0	0	0
West South Central.....	6,200	0.07	16,600	0.10	1.76	2.02
Mountain.....	4,163,500	49.00	7,777,600	46.09	47.89	48.22
Pacific.....	4,315,000	50.78	9,054,000	53.65	37.51	39.23
United States..	8,497,600	100.00	16,874,500	100.00	30.41	31.30

Ninety-seven per cent of the net area of the national forests (excluding Alaska and lands purchased under the Weeks law) are in the Pacific and Mountain States. The remaining 3 per cent are found in detached areas in the States of Arkansas, Florida, Kansas, Michigan, Minnesota, Nebraska, North Dakota, Oklahoma, and South Dakota. Of the potential water powers in the national forests, 99½ per cent is in the Mountain and Pacific States. Water powers on the national forests within these two groups of States amount to 42 per cent of the total estimated minimum and 43 per cent of the total estimated maximum of potential water powers within the groups.

These figures of potential power within the national forests differ somewhat from figures previously given, on account of errors found in the estimates prepared by the Forest Service in 1910. For the purposes of this report and in order that the estimates might be comparable, the endeavor has been made to prepare national-forest estimates on precisely the same basis as the Geological Survey estimates were prepared, but using a 75 per cent efficiency factor. The same caution should be observed in the use of these figures as in the general estimates of the survey. Their chief value is for comparative purposes, as indicating the distribution of national-forest water-power resources and their relation to similar resources of the several States and to the United States as a whole.

DEVELOPED POWER IN THE UNITED STATES.

SCOPE OF THE REPORT.

The development of water power is so closely associated with the electrical industry and so related to the other sources of primary power, particularly steam power, that no clear understanding can be had of the problems of water-power development without a parallel study of steam-power and gas-power development, and of the utilization of these three sources of primary power in central electric stations, by street and electric railways, and in manufactures. This section of the report will therefore deal with the extent, distribution, and utilization by States and by geographic divisions of the three sources of primary power, considered both in the aggregate and per capita.

SOURCES OF INFORMATION.

The Bureau of the Census collects at five-year intervals statistics of power development in the United States. Such statistics in sufficient detail for compara-

tive studies are available for the years 1902, 1907, and 1912 for central stations and for street and electric railways. Statistics of power used in manufactures are also collected at similar intervals but for different years. Data for the years 1899, 1904, and 1909 as published in the Census of Manufactures, 1910, have been used in this report. In addition to the census data, information has been secured from the McGraw Electrical Directory, April, 1915; the McGraw's Electric Railway Directory, August, 1914; Moody's Manual of Railroad and Corporation Securities, 1915; Poor's Manual of Public Utilities, 1914; reports of the several State public utilities commissions; reports of the Geological Survey and of the engineers of the Forest Service; engineering periodicals; and an extended correspondence with power companies. The different sources of information do not always agree, but in case of disagreement that information which seems the most reliable has been used.

Plate I

GEOGRAPHIC DIVISIONS AS DEFINED BY THE BUREAU OF THE CENSUS.

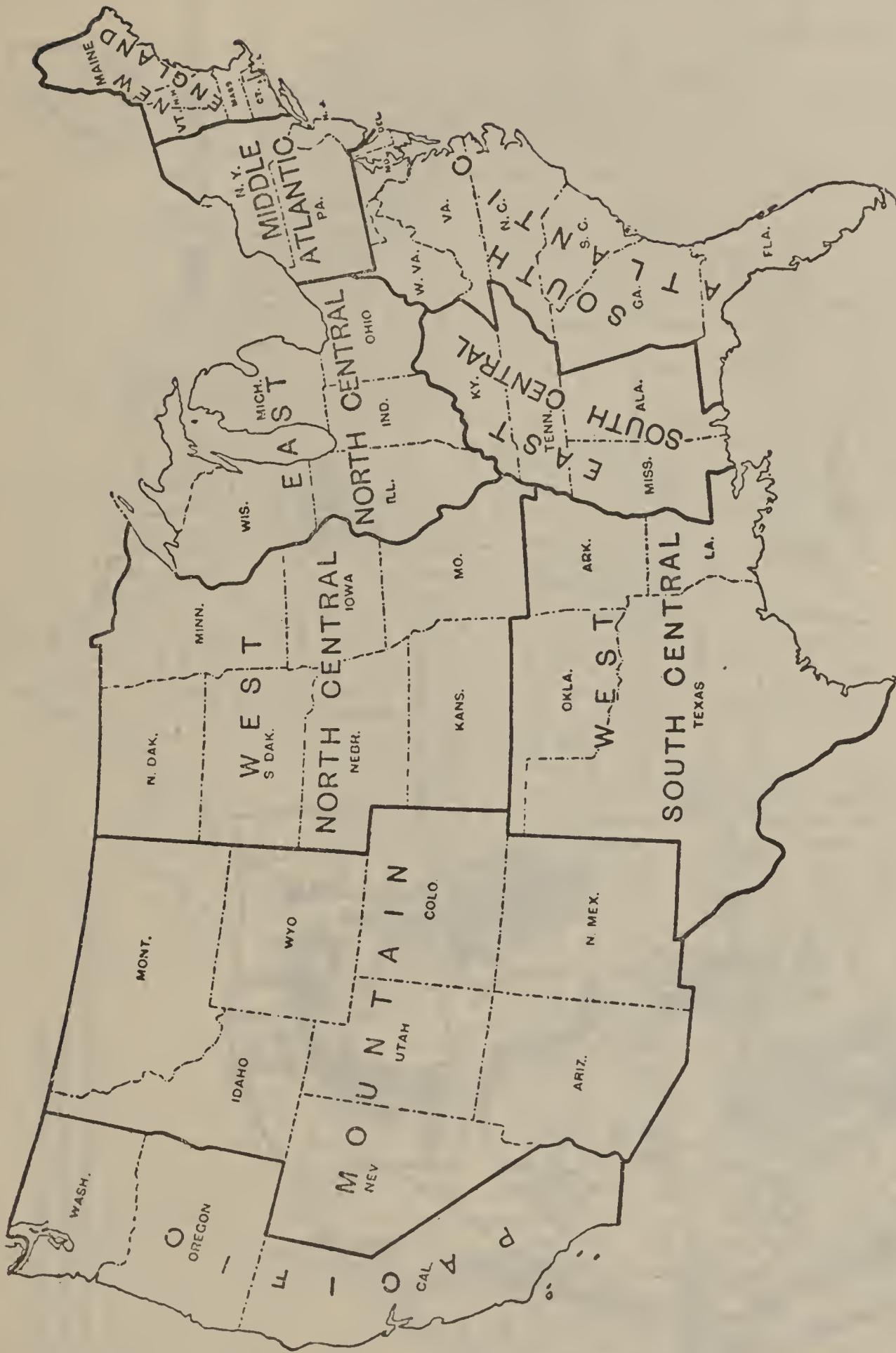


PLATE II.

NATIONAL FORESTS AND DRAINAGE OF THE UNITED STATES.



REPORTS OF THE BUREAU OF THE CENSUS.

This report contains census data for central electric light and power stations, street and electric railways, and power used in manufactures. These three classifications cover practically all the power used for all purposes in the United States. Classes of uses for which no data have been collected by the Bureau of the Census comprise so small an amount of total power as to be negligible.

CLASSES OF STATIONS.

The 1912 report of the Bureau of the Census for central electric light and power stations and street and electric railways contains the following statement concerning the classification of stations:

The statistics for central electric stations represent all stations which furnish electrical energy for light, power, and heat; for manufacturing, mining, and other commercial enterprises; for private dwellings; and for public uses, such as lighting streets, parks, etc. The statistics for electric stations operated by electric railways are included whenever it was practicable to secure a separate report for the central-station work. No reports were required for electric stations operated by mining companies, factories, hotels, etc., which consume all current generated, nor for those operated by the Federal Government and State institutions. Neither were reports required for stations that were idle or in course of construction. * * *

The number of central electric stations reported, 5,221, is considerably less than the number reported in commercial directories. This apparent discrepancy is due to the fact that in collecting the census statistics when a number of plants were operated under the same ownership it often was impracticable to secure a separate report for each, and therefore a single report was made to cover the operations of all and they were counted as one plant. In preparing the directories apparently each plant is treated as a separate unit. Although the number of stations in this report is less than the number accounted for in the directories, this difference is due to the census definition of the term "station," which may represent a single electric station or a number of stations which have been combined under the same ownership. These combinations embrace stations of varying characteristics as to primary power, generating and line equipment, and character of service. They have in common, however, the practice of disposing of electrical energy, either direct to consumers for light, heat, or power, or in bulk to some other public-service corporation. All or only a part of the stations embraced in a combination may have generating equipment or the combination may embrace several generating stations which send the electrical energy over transmission lines to a single distributing center.

From year to year more or less of the central electric stations are merged with electric railways. These stations, nevertheless, are properly enumerated in the directories as separate stations, but are included in the census reports as a part of the electric railway industry except when separate reports can be prepared for the electric light and power departments.

* * * * *

Statistics for commercial central stations and for street and electric railways in the States of Oregon and Washington in particular and in a lesser degree for certain other States are confused by the classification of stations sometimes as central stations and sometimes as electric railway stations. In the two States named it appears that plants operated by the Portland Railway Light & Power Co. and by the Puget Sound Traction Light & Power Co., each being the largest operating concern in its State, were classed as central stations in 1907 and as electric railway stations in 1912. Both are central station companies which also operate electric railways. Their chief business, however, is in furnishing light and power for sale, and they should more properly have been classified as central stations in 1912. The effect of the change in the classification upon the comparative positions which these two States occupy in these two lines

of business appears most clearly in the diagrams given in Part II of this report.

Commercial and municipal stations are distinguished in the reports of the Bureau of the Census as follows:

Central electric stations are divided into two groups—commercial and municipal. The commercial stations are those operated by individuals, firms, and corporations as distinguished from stations operated by municipalities.

The municipal stations often extend their operations into the commercial field and sell electricity to the general consumer.

UNITS EMPLOYED.

The census statistics for primary power are expressed in horsepower; for generator and motor capacities, in kilowatts, and for amount of power generated, in kilowatt-hours. In order that the data as appearing in this report might be the more readily comparable, generator and motor capacities in kilowatts have been reduced to equivalent horsepower by multiplying by 0.746 the ratio of the horsepower to the kilowatt, and power generated in kilowatt-hours has been reduced to horsepower-years by dividing by 6,535 the number of kilowatt hours in a horsepower year.

GROUPING OF POWER STUDIES.

In the investigation of power development the census statistics of both primary power and power generated have been computed and classified for the purposes of this report under two general groupings, (1) "Sources of power," and (2) "Uses of power." The sources of power considered are:

(a) Water power.

(b) Steam power.

(c) Gas power.

And the uses:

(d) Commercial central stations.

(e) Municipal central stations.

(f) Street and electric railways.

(g) Manufactures.

Tables and diagrams giving the data for each class in each group in combination with all the classes in the other group are presented in Part II of this report. Tables are arranged by States and by geographic divisions, using the same order in all tables. In the diagrams the States and geographic divisions are arranged in the order of magnitude either of primary power or of power generated in the group and class under consideration, in order that the relative importance of power development in the several States or groups of States may be more readily apparent. Studies have been made in all cases of primary power and of power output, both in the aggregate and per capita. In both tables and diagrams the figures are given for the three census years of 1902, 1907, and 1912.

In making these studies, special attention has been directed to a determination of the position which the Western States hold in power development in general, and in water-power development in particular. On account of repeated assertions, supported, however, by no proof, the impression has become current that power development, especially water-power development, is "stagnant" in the western or public-land States. To determine whether such assertions have any foundation in fact, a careful analysis has been made of the census data with respect to the total development of the various sources and uses of power in the several sections of the United States, to the rate of increase in such developments by census periods, and to the in-

tensity of such developments as represented by the amount of development in horsepower per thousand of population. The results of this analysis appear in detail in the succeeding pages.

PRIMARY POWER EQUIPMENT.

The primary power equipment, as reported to the Bureau of the Census, includes steam engines and steam turbines, gas and oil engines, and water wheels, water turbines, and water motors. Throughout the report the term "steam power" includes steam engines and steam turbines; "water power," water wheels, turbines, and motors; and "gas power," internal-combustion engines using either gas or oil fuel.

TOTAL PRIMARY POWER—ALL SOURCES, ALL USES.

The total primary power in the United States, in commercial and municipal central stations, street and electric railway stations, and in manufacturing plants, as estimated and reported for the year 1912, was 30,448,246 horsepower, of which 16 per cent was water power, 80 per cent steam power, and 4 per cent gas power. By classes of uses, 22.9 per cent was in commercial central stations, 1.8 per cent in municipal central stations, 12.1 per cent in electric railway stations, and 63.2 per cent in manufacturing plants.

The percentage increase in the several classes of uses was as follows:

	1902-1912	1902-1907	1907-1912
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Commercial central stations.....	¹ 314	124	¹ 85
Municipal central stations.....	250	101	74
Street and electric railways.....	¹ 170	85	¹ 45
Manufactures.....	63	30	25
Total primary power.....	103	47	38

¹ The percentages for commercial central stations are a little too low and those for electric railways a little too high on account of the classification of certain stations in Oregon and Washington by the Bureau of the Census.

And in the several sources of power as follows:

	1902-1912	1902-1907	1907-1912
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Water power.....	137	55	52
Steam power.....	96	44	36
Gas power.....	155	74	47
Total primary power.....	103	47	38

By individual States Pennsylvania leads with 3,990,342 horsepower, followed by New York with 3,533,091 horsepower, and Ohio with 2,397,384 horsepower. These three States had nearly a third of the total estimated and reported primary power in the United States in 1912. Four other States—Illinois, Massachusetts, California, and Michigan, in the order named—had over a million horsepower each. These seven States with a total of 15,682,186 horsepower had more than one-half the total for the United States. By geographic divisions the Middle Atlantic States lead, followed in order by the East North Central, the New England, the South Atlantic, the Pacific, and West South Central States.

In rate of increase by periods the Pacific States lead, followed by the Mountain States. These two groups combined increased 102 per cent from 1902 to 1907, 72 per cent from 1907 to 1912, and 248 per cent from 1902 to 1912, as compared with 47 per cent, 38 per

cent, and 103 per cent for the United States as a whole. Primary-power installation in the Western States increased 248 per cent for the 10 years 1902 to 1912, or 2.6 times as fast as in the remainder of the United States and three times as fast as in the Eastern States comprised in the three groups along the Atlantic coast.

The percentages of increase for the several geographic divisions by census periods are given in the following table. Details for the several States may be found in Table No. 3 and on plate 3, Part II.

TABLE No. 3.—Percentage increases in primary power, all sources, all uses, by geographic divisions.

	1902-1912	1902-1907	1907-1912
New England.....	64	27	29
Middle Atlantic.....	81	40	29
East North Central.....	101	44	40
West North Central.....	121	55	42
South Atlantic.....	133	69	45
East South Central.....	101	49	35
West South Central.....	139	62	46
Mountain.....	201	82	65
Pacific.....	273	112	76
United States.....	103	47	38

TOTAL PRIMARY POWER, ALL SOURCES, ALL USES, PER THOUSAND OF POPULATION.

The average power installation in the United States for all purposes and from all sources in 1912 was 318.8 horsepower per thousand of population, an increase from 251.3 horsepower in 1907 and 188.9 horsepower in 1902. On this basis the New England States lead with 577.9 horsepower, nearly twice the average for the United States. The Pacific and Mountain groups combined had 413.4 horsepower. Among the individual States New Hampshire led with 912.6 horsepower per thousand, followed by Maine with 823.7 horsepower, Vermont with 587.7 horsepower, Rhode Island with 582.9 horsepower, Washington with 526.4 horsepower, Massachusetts with 510.2 horsepower, Pennsylvania with 500.8 horsepower, and Oregon with 500.6 horsepower. These eight are the only States with a per capita installation in excess of 0.5 horsepower.

The total primary power installation per thousand of population in the United States for the three years 1912, 1907, and 1902 was distributed among the several classes of uses as follows:

	1912	1907	1902
	<i>Horse-power.</i>	<i>Horse-power.</i>	<i>Horse-power.</i>
Commercial central stations.....	73.0	43.2	21.2
Municipal central stations.....	5.9	3.7	2.0
Street and electric railways.....	38.4	28.8	17.1
Manufactures.....	201.6	175.7	148.6
Total primary power.....	¹ 318.8	¹ 251.3	188.9

¹ Totals do not check in the last place, on account of fractions in the subtotals.

And among the several sources as follows:

	1912	1907	1902
	<i>Horse-power.</i>	<i>Horse-power.</i>	<i>Horse-power.</i>
Water power.....	51.0	36.5	25.9
Steam power.....	254.8	205.2	156.9
Gas power.....	13.0	9.6	6.1
Total.....	318.8	251.3	188.9

The total primary power per thousand of population for the several geographic divisions for the years 1912, 1907, and 1902 is given in the following table and diagram (Plate III). Details for the several States appear in Tables Nos. 18, 19, and 5, and on plates 4 and 5, Part II.

TABLE No. 4.—Primary power per thousand of population, all sources, all uses, by geographic divisions, in horsepower.

	1912	1907	1902
New England.....	577.9	484.6	412.4
Middle Atlantic.....	419.3	359.4	287.1
East North Central.....	379.0	288.9	214.5
West North Central.....	174.0	129.4	88.5
South Atlantic.....	234.0	173.1	117.1
East South Central.....	174.8	136.6	97.0
West South Central.....	146.8	114.0	81.5
Mountain.....	321.3	234.4	161.8
Pacific.....	470.6	332.8	207.6
United States.....	318.8	251.3	188.9

TOTAL WATER POWER, ALL USES.

The total water power in the United States in 1912, as reported for commercial and municipal central stations and street and electric railways, and as estimated for manufacturing plants, was 4,870,320 horsepower, or 16 per cent of the total power from all sources. By classes of uses, 48 per cent was in commercial central stations, 2.7 per cent in municipal central stations, 9.7 per cent in street and electric railway stations, and 39.6 per cent in manufacturing plants.

The percentages of increase of water-power installation in the several classes of uses are as follows:

	1902-1912	1902-1907	1907-1912
	Per cent.	Per cent.	Per cent.
Commercial central stations.....	1 448	209	1 78
Municipal central stations.....	1,050	171	330
Street and electric railways.....	1 858	87	1 412
Manufactures.....	23	12	10
Total water power.....	137	55	52

¹ The percentages for commercial central stations are somewhat too low, and of street and electric railways too high, on account of the classification by the Bureau of the Census of certain stations in Oregon and Washington.

By individual States, New York leads, with 896,229 horsepower, followed by California, with 440,243 horsepower, and Maine, with 387,073 horsepower. Five other States, Washington, Wisconsin, South Carolina, Massachusetts, and New Hampshire, had more than 200,000 horsepower.

By geographic divisions, the Middle Atlantic States lead, with 1,109,317 horsepower; New England is second, with 1,059,800 horsepower, and the Pacific States third, with 888,810 horsepower.

In rate of increase from 1902 to 1912 the Pacific States lead, with 505 per cent, followed by the Mountain States, with 353 per cent. These two groups combined increased 451 per cent in the 10-year period, or 4.6 times as fast as in the remainder of the United States, and 5.2 times as fast as in the Eastern States included within the three Atlantic coast groups.

The percentage of increases for the several geographic divisions by periods are given in the following table. Details for the several States may be found in Table No. 6 and on plate 7, Part II:

TABLE No. 5.—Percentage increase in water power, all uses, by geographic divisions.

	1902-1912	1902-1907	1907-1912
New England.....	49	21	23
Middle Atlantic.....	80	38	32
East North Central.....	131	53	51
West North Central.....	182	116	30
South Atlantic.....	278	106	83
East South Central.....	178	41	97
West South Central.....	168	42	89
Mountain.....	353	112	113
Pacific.....	505	187	111
United States.....	137	55	53

WATER POWER, ALL USES, PER THOUSAND OF POPULATION.

The average water-power installation in the United States in 1912 for all uses was 51 horsepower per thousand of population, an increase from 36.5 horsepower in 1907 and 25.9 horsepower in 1902. In per capita installation, Maine, New Hampshire, and Vermont lead in the order named with 514 horsepower, 468.7 horsepower, and 336.4 horsepower, respectively, per thousand of population. Three other States, Montana, Washington, and Oregon, had over 200 horsepower.

By geographic divisions the Pacific States lead with an average of 193.7 horsepower, followed by New England with 156.6 horsepower, and the Mountain States with 126.4 horsepower. The 11 Western States have an average of 167.9 horsepower, 4.1 times the average for the remainder of the United States and 2.4 times the average for those Eastern States included in the Atlantic coast groups.

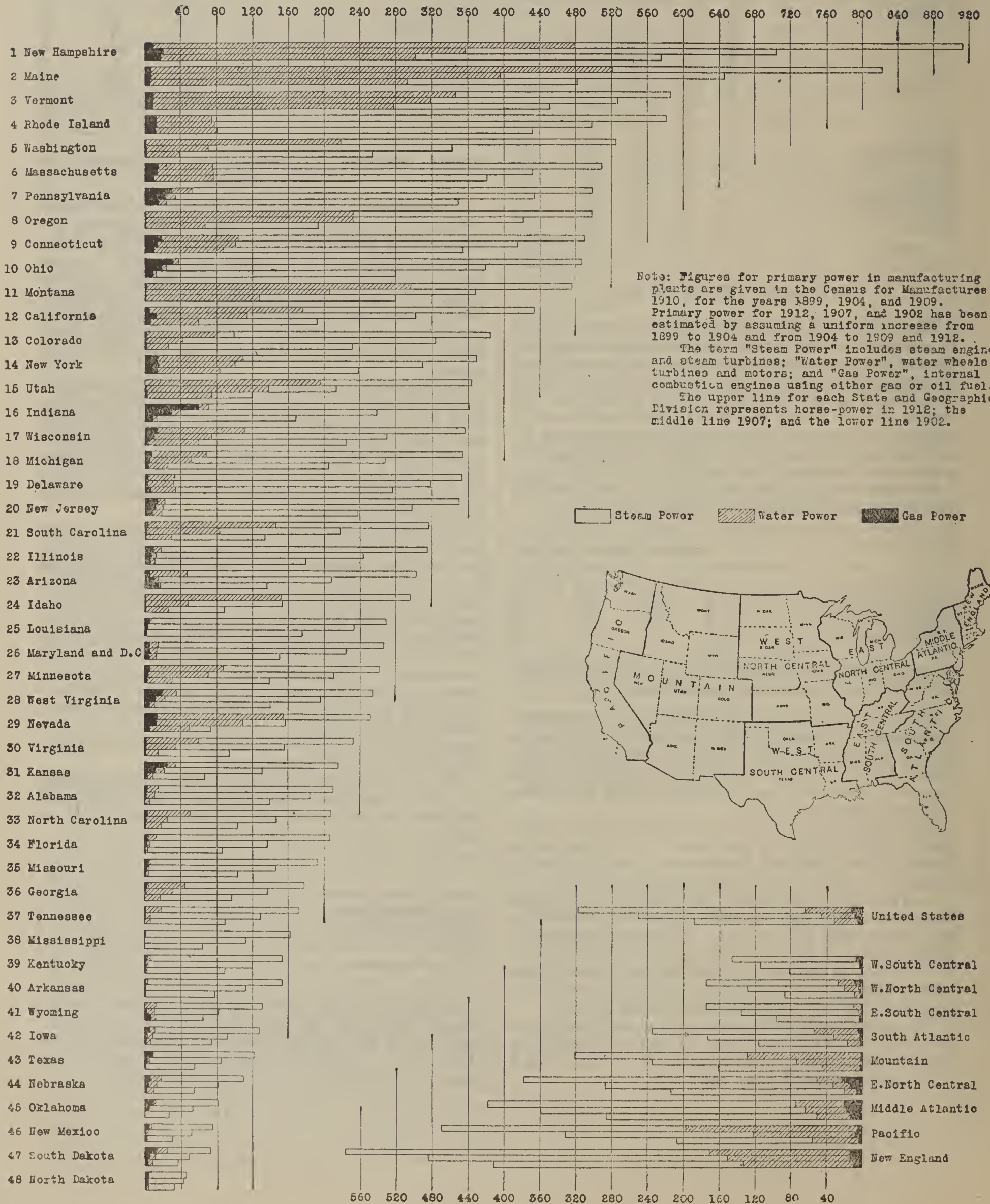
The water-power development of the Western States has been and continues to be almost entirely in connection with the electrical industry, an industry which had its beginning scarcely more than 20 years ago. Water-power development in the Eastern States, on the other hand, has long been associated with manufactures. Hundreds if not thousands of small water powers are used for this purpose, and development dates backward for a century. A consideration of this situation makes more significant the remarkable water-power development that took place in the Western States in the 10 years from 1902 to 1912. Data collected since the census reports and which will be considered later show that this rapid rate is still continuing.

Water-power installation per thousand of population for the United States for the years 1912, 1907, and 1902 was divided among the several classes of uses as follows:

	1912	1907	1902
Commercial central stations.....	24.5	15.1	5.4
Municipal central stations.....	1.4	.3	.1
Street electric railways.....	4.9	1.0	.6
Manufactures.....	20.2	20.1	19.8
Total water power.....	51.0	36.5	25.9

Water power per thousand of population for the several geographic divisions for the years 1912, 1907, and 1902, is given in the following table and diagram (Plate IV). Details for the several States may be found in Table No. 7 and on plate 8, Part II.

Steam Power, Water Power, and Gas Power
By States and By Geographic Divisions
In Horse-Power



WATER POWER - INSTALLED CAPACITY PER THOUSAND OF POPULATION IN 1912, 1907 and 1902

PLATE IV

In Commercial and Municipal Central Stations, Street and Electric Railways, and Manufacturing Plants
By States and by Geographic Divisions
In Horse-Power

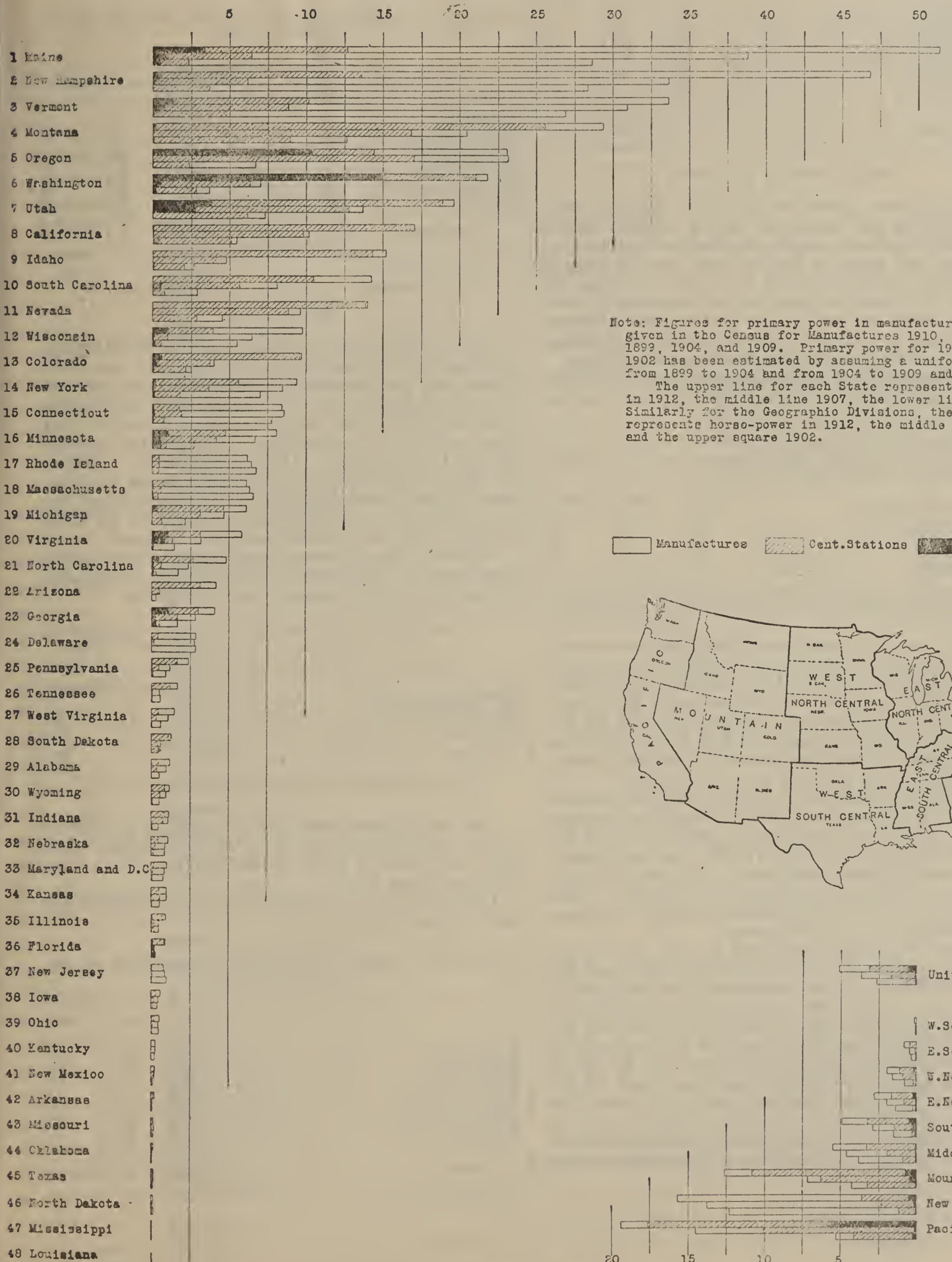


TABLE NO. 6 — *Water power per thousand of population, all uses, by geographic divisions.*

	1912	1907	1902
New England.....	156.6	137.4	122.7
Middle Atlantic.....	54.9	45.9	38.0
East North Central.....	27.8	19.6	13.8
West North Central.....	19.5	15.9	7.8
South Atlantic.....	48.9	28.7	15.1
East South Central.....	8.1	4.3	3.3
West South Central.....	1.3	.7	.6
Mountain.....	126.4	71.4	42.4
Pacific.....	193.7	114.5	52.7
United States.....	51.0	36.5	25.9

STEAM POWER, ALL USES.

The total steam power in the United States in 1912 in commercial and municipal central stations, street and electric railways, and in manufacturing plants, as estimated and reported for the year, was 24,339,819 horsepower, or 80 per cent of the total power from all sources. By classes of uses 18.6 per cent was in commercial central stations, 1.7 per cent in municipal central stations, 13 per cent in street and electric railway stations, and 66.7 per cent in manufacturing plants. The percentages of increase in steam-power installation, according to the several classes of uses, are as follows:

	1902-1912	1902-1907	1907-1912
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Commercial central stations.....	¹ 265	93	¹ 88
Municipal central stations.....	175	93	43
Street and electric railways.....	¹ 142	84	¹ 32
Manufactures.....	66	32	26
Total steam power.....	96	44	36

¹ The percentages for commercial central stations are somewhat too low and for street and electric railways somewhat too high, on account of the classification of certain central stations in Oregon and Washington by the Bureau of the Census.

Among the individual States, Pennsylvania was first, with an estimated and reported installation of 3,565,991 horsepower, one-seventh of the total for the United States. The three States of Pennsylvania, New York, and Ohio had a combined installation of 8,268,888 horsepower, or more than a third of the total for the United States. Two other States, Illinois and Massachusetts, had over a million horsepower each. By geographic divisions the Middle Atlantic and East North Central States lead with a combined installation of 13,089,685 horsepower, or 54 per cent of the total for the United States. The Mountain and Pacific States show the least installation, with 547,536 horsepower and 1,254,375 horsepower, respectively. Their combined steam-power installation is only 7.4 per cent of the total for the United States.

In rate of increase from 1902 to 1912, the Pacific and Mountain States lead, with 198 per cent and 151 per cent, respectively, as compared with increases of 353 per cent and 505 per cent in water-power installation. While steam is the chief source of power in the Eastern and Central States, and in the majority of power systems the only source of power, in the Western States steam power has been developed for the most part to furnish auxiliary service in connection with hydroelectric-power systems. This explains in large measure the more rapid rate of increase in steam-power development in the Western States than in other sections.

The percentages of increase for the several geographic divisions by census periods are given in the following table. Details for the several States may be found in Table No. 8 and on plate 12, Part II.

TABLE NO. 7.—*Percentage increases in steam power, all uses, by geographic divisions.*

	1902-1912	1902-1907	1907-1912
New England.....	70	29	31
Middle Atlantic.....	81	41	29
East North Central.....	93	41	37
West North Central.....	111	48	42
South Atlantic.....	110	53	38
East South Central.....	97	49	32
West South Central.....	130	60	44
Mountain.....	151	74	45
Pacific.....	198	84	62
United States.....	96	44	36

STEAM POWER, ALL USES, PER THOUSAND OF POPULATION.

The average steam installation in the United States, as estimated and reported for the year 1912, was 254.8 horsepower per thousand of population, an increase from 205.2 horsepower in 1907 and 156.9 horsepower in 1902. The New England States occupied first place with 406.8 horsepower, 1.6 times the average for the United States. The average for the 11 Western States is 242.3 horsepower, a little below the average for the United States; for the remainder of the United States it is 255.8 horsepower, and for the three eastern groups 302.3 horsepower per thousand. The total steam power installation per thousand of population in 1912, 1907, and 1902 was distributed among the several classes of uses as follows:

	1912	1907	1902
	<i>Horsepower.</i>	<i>Horsepower.</i>	<i>Horsepower.</i>
Commercial central stations.....	47.5	27.5	15.7
Municipal central stations.....	4.3	3.2	1.9
Street and electric railways.....	33.2	27.6	16.5
Manufactures.....	168.9	146.9	122.8
Total.....	¹ 254.8	205.2	156.9

¹ Total does not check in last place on account of fractions in subtotals.

The total steam power per thousand of population for the several geographic divisions for the years 1912, 1907, and 1902 is given in the following table and diagram (Plate V). Details for the several States appear in Table No. 9 and on plate 13, Part II.

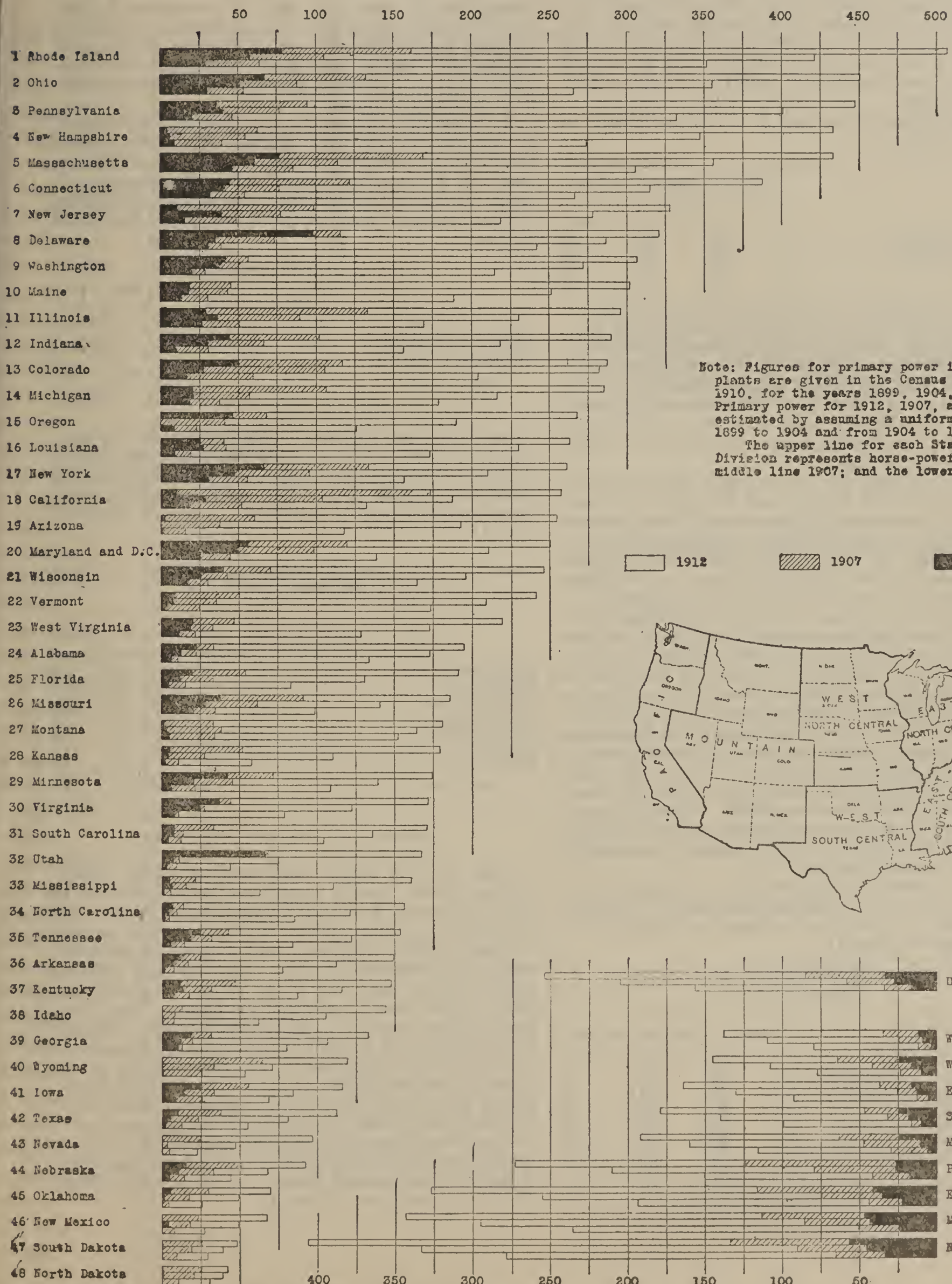
TABLE NO. 8.—*Steam power per thousand of population, all uses, by geographic divisions.*

	1912	1907	1902
New England.....	406.8	333.6	278.8
Middle Atlantic.....	343.8	295.4	235.6
East North Central.....	327.9	255.1	193.6
West North Central.....	145.5	108.3	77.6
South Atlantic.....	179.6	140.6	99.7
East South Central.....	164.2	130.8	92.9
West South Central.....	138.5	110.1	80.0
Mountain.....	192.2	160.2	116.0
Pacific.....	273.3	210.1	150.7
United States.....	254.8	205.2	156.9

STEAM POWER - INSTALLED CAPACITY PER THOUSAND OF POPULATION IN 1912, 1907 AND 1902

PLATE V

In Commercial and Municipal Central Stations, Street and Electric Railways, and Manufacturing Plants
By States and by Geographic Divisions
In Horse-Power



GAS POWER, ALL USES.

The total gas power in the United States in 1912 as reported for commercial and municipal central stations and street and electric railways and as estimated for manufacturing plants was 1,238,107 horsepower, or 4 per cent of the total power from all sources. By classes of uses 7.2 per cent was in commercial central stations, 1.8 per cent in municipal central stations, 2 per cent in street and electric railways, and 89 per cent in manufactures.

The percentages of increase in the several classes of uses are as follows:

	1902-1912	1902-1907	1907-1912
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Commercial central stations	690	334	82
Municipal central stations	2,240	536	253
Street and electric railways	1,160	798	48
Manufactures	133	63	43
Total gas power	155	74	47

By individual States Pennsylvania leads, with 233,395 horsepower. Only five other States, Indiana, Ohio, New York, Illinois, and Massachusetts, had over 50,000 horsepower. By geographic divisions the East North Central States lead with 436,943 horsepower, followed closely by the Middle Atlantic States with 415,335 horsepower. These two groups had 69 per cent of the total in the United States.

In rate of increase for the 10 years, 1902-1912, the West South Central States lead with 990 per cent. This is due to increases in Oklahoma and Texas between 1907 and 1912, and chiefly in the estimated increase in manufacturing use. One group, the Pacific States, shows a reduction for 1907 to 1912, due to the falling off in commercial central station use for the period.

As indicating the actual total use of gas and oil engines the figures as given in the census report can not be considered as even approximately correct. An unknown but very considerable amount of gas power is used for irrigation pumping in the Pacific and Mountain States and for drainage purposes in the South Central States. These uses are not included in the census reports. While a certain amount of steam power is also used for such purposes, as well as for other purposes not reported by the census, the percentage error caused by the omission is very small. With gas power, on the other hand, the error is undoubtedly very large in the groups of States named, probably amounting to several hundred per cent.

Rates of increase in the amounts as estimated and reported are given by geographic divisions in the following table. Details may be found in Table No. 10 and on plate 16, Part II.

TABLE No. 9.—Percentage increase in gas power, all uses, by geographic divisions.

	1902-1912	1902-1907	1907-1912
New England	55	34	15
Middle Atlantic	90	51	26
East North Central	275	114	75
West North Central	235	80	86
South Atlantic	181	81	55
East South Central	251	99	76
West South Central	990	341	147
Mountain	21	7	13
Pacific	40	156	-83
United States	155	74	47

GAS POWER, ALL USES, PER THOUSAND OF POPULATION.

The average gas power installed in the United States in 1912, as reported for central stations and electric railways and as estimated for manufactures was 13 horsepower, an increase from 9.6 horsepower in 1907 and 6.1 horsepower in 1902. In per capita installation Indiana leads with 60.3 horsepower per thousand of population. Only four other States, Ohio, Pennsylvania, Kansas, and West Virginia, had in excess of 20 horsepower per thousand.

By geographic divisions the East North Central, Middle Atlantic, and New England States lead in the order named with 23.3 horsepower, 20.6 horsepower, and 14.5 horsepower, respectively. The average installation for the United States was divided among the several classes of uses for the three census periods as follows:

	1912	1907	1902
Commercial central stations	0.9	0.5	0.2
Municipal central stations2	.1	.0
Street and electric railways3	.2	.0
Manufactures	11.6	8.8	5.9
Total gas power	13.0	9.6	6.1

Gas power per thousand of population for the several geographic divisions, as reported and estimated for the years 1912, 1907, and 1902, is given in the following table and diagram (Plate VI). Details for the several States may be found in Table No. 11 and on plate 16, Part II.

TABLE No. 10.—Gas power per thousand of population, all uses, by geographic divisions.

	1912	1907	1902
New England	14.5	13.6	10.9
Middle Atlantic	20.6	18.1	13.5
East North Central	23.3	14.2	7.1
West North Central	9.0	5.2	3.0
South Atlantic	5.5	3.8	2.3
East South Central	2.4	1.5	.8
West South Central	7.0	3.2	.9
Mountain	2.7	2.8	3.4
Pacific	3.6	8.2	4.2
United States	13.0	9.6	6.1

COMMERCIAL CENTRAL STATIONS.

Total primary power.—The total of steam, water, and gas power, used in commercial central stations in 1912 aggregated 6,969,320 horsepower, or 23 per cent of the total primary power for all purposes—central stations, electric railways and manufactures—estimated and reported for the year. Of the total in 1912, 33.6 per cent was water power; 65.1 per cent steam power; and 1.3 per cent gas power. New York leads with a total of 1,144,308 horsepower, followed by California with 838,693 horsepower, and Pennsylvania with 600,554 horsepower. The three leading groups of States are the Middle Atlantic with 1,981,623 horsepower, East North Central with 1,510,373 horsepower, and the Pacific States with 918,294 horsepower.

The percentages of increase by geographic divisions for the census periods are shown in the following table. Details for the several States can be found in Table No. 12 and on plate 17, Part II.

GAS AND OIL ENGINES - INSTALLED CAPACITY PER THOUSAND OF POPULATION IN 1912, 1907 AND 1902

PLATE VI

In Commercial and Municipal Central Stations, Street and Electric Railways, and Manufacturing Plants
By States and by Geographic Divisions
In Horse-Power

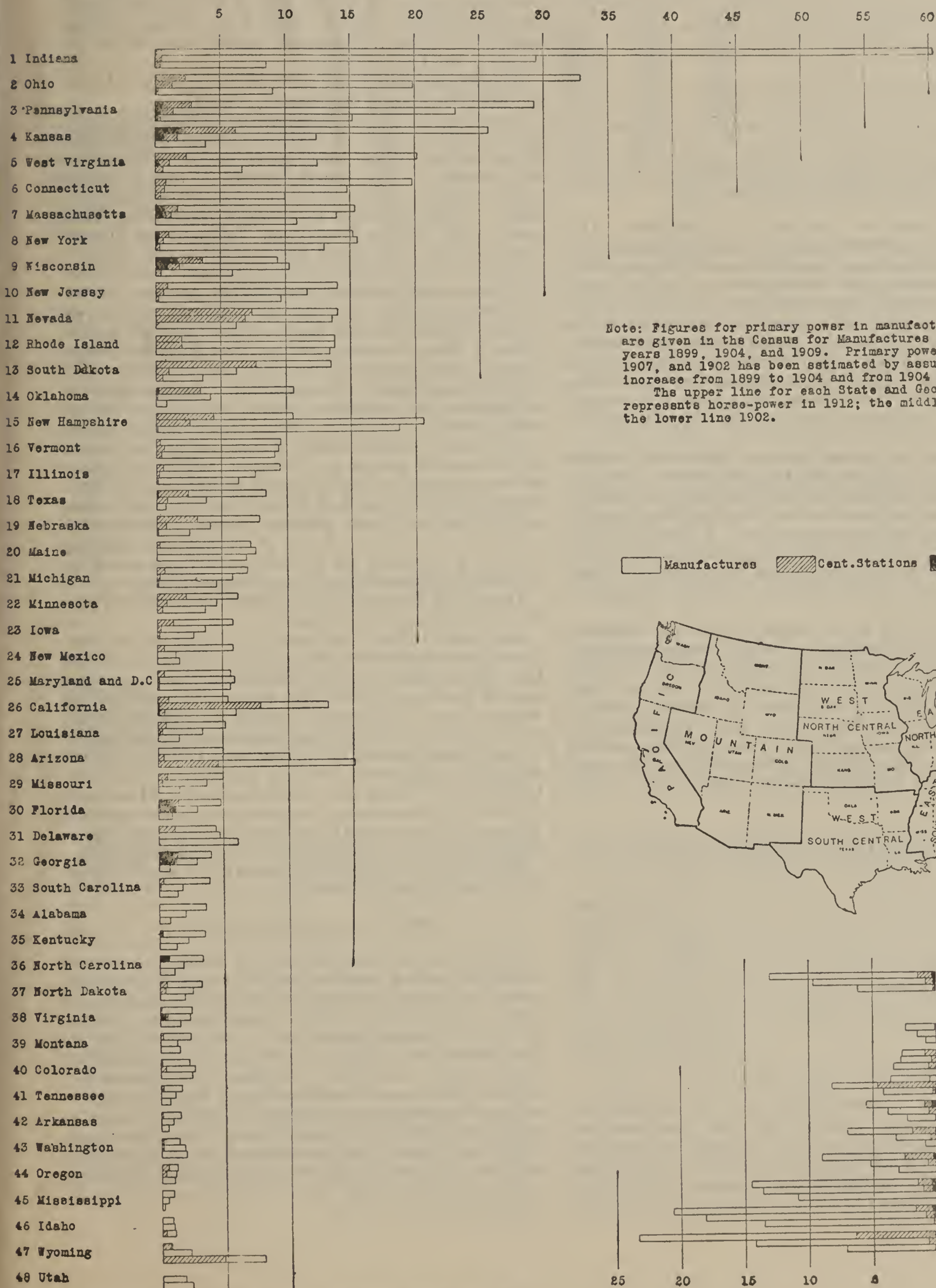


TABLE NO. 11.—Percentages of increase in primary power, commercial central stations, by geographic divisions.

	1902-1912	1902-1907	1907-1912
New England.....	192	64	79
Middle Atlantic.....	258	97	82
East North Central.....	387	131	111
West North Central.....	308	158	58
South Atlantic.....	590	222	118
East South Central.....	289	92	103
West South Central.....	258	112	69
Mountain.....	297	111	88
Pacific.....	¹ 433	229	¹ 62
United States.....	¹ 314	124	¹ 85

¹ These percentages are too small on account of the classification by the Bureau of the Census of considerable amounts of commercial central-station power as electric-railway power in the States of Oregon and Washington in 1912.

Primary power per thousand of population.—The data for power development are most significant when reduced to amounts per capita, for on this basis they show the intensity of development. On this basis California leads with 325.4 horsepower per thousand, or four and one-half (4.46) times the average for the United States, followed by Montana with 282.9 horsepower, or nearly four (3.90) times the average for the United States. The highest amount outside of the Pacific and Mountain States is in New Hampshire, which has 190.9 horsepower per thousand of population.

Amounts for the several groups of States and for the United States appear in the following table. Figures for the Pacific group in 1912 are too low on account of incorrect classification in certain States by the Bureau of the Census, as heretofore noted. Figures for primary power in commercial central stations in horsepower per thousand of population are given in the first three columns of Table 18 and are shown on plate 18, Part II.

There is twice as much primary power per capita in central station development in the Mountain States and probably more than three times as much in the Pacific States as in the United States as a whole. The relative intensity of development of electric power in the several sections will appear more clearly in the consideration of the combined power developments of commercial central stations, municipal central stations, and street and electric railways, which will be discussed later.

TABLE NO. 12.—Primary power per thousand of population, commercial central stations, by geographic divisions, in horsepower.

	1912	1907	1902
New England.....	101.8	61.6	40.7
Middle Atlantic.....	98.2	59.9	34.0
East North Central.....	80.5	40.7	18.8
West North Central.....	43.4	29.1	11.9
South Atlantic.....	44.0	22.1	7.4
East South Central.....	20.9	10.8	6.0
West South Central.....	21.7	14.7	8.1
Mountain.....	146.3	93.6	55.9
Pacific.....	200.1	153.8	61.8
United States.....	73.0	43.2	21.2

Water power.—The total water-power installation of commercial central stations in 1912 was 2,340,820 horsepower, or 48 per cent of the total water-power development for all purposes in the United States. New York shows the largest development with 510,521 horsepower, followed by California with 430,312 horse-

power. Considering development by sections, the Middle Atlantic States lead with 643,677 horsepower, followed by the Pacific States with 476,476 horsepower. The total for the Pacific group is too low on account of the classification by the Bureau of the Census of certain commercial central stations as electric railway stations in 1912. This classification also affects the total for the United States.

The detailed data for the several States may be found in Table No. 12 and on plate 17, Part II.

Steam power.—The installation in commercial central stations was reported as 4,539,866 horsepower in 1912, or 18.6 per cent of the total steam power developed for all purposes in the United States. It was, however, nearly twice the water-power installation in such stations. In steam power as in water power New York leads with 628,486 horsepower, followed by Illinois with 582,506 horsepower, Pennsylvania with 452,767 horsepower, and California with 406,401 horsepower. By geographic divisions the Middle Atlantic States lead with 1,314,357 horsepower, followed closely by the East North Central States with 1,269,337 horsepower. Next in order are the New England States with 483,612 horsepower and the Pacific States with 439,463 horsepower. Were it not for the classification of stations as referred to above the Pacific States would probably rank ahead of the New England States.

The ratio between steam power and water power in the several groups is of interest. While the ratio of steam power to water power is 5.65 in the East North Central States, 2.41 in the New England States, and 2.04 in the Middle Atlantic States, it is only 0.92 in the Pacific States and 0.34 in the Mountain States, showing a relatively far greater use of water power in the Western States than in the Eastern States.

Details for the several States may be found in Table No. 12 and on plate 17, Part II.

Gas power.—This has found but small use in commercial central station development. The total for the United States is but 88,364 horsepower, less than 4 per cent of the water power and about 2 per cent of the steam power. Pennsylvania leads with 16,088 horsepower, 18 per cent of the total within the United States. Texas is second with 9,339 horsepower, Oklahoma third with 5,320 horsepower, and New York fourth with 5,301 horsepower. These four States have over 40 per cent of the total gas power in commercial central stations. Although California led in 1907 with 16,585 horsepower, the amount was reduced in 1912 to 1,980 horsepower.

Details for the several States may be found in Table No. 12 and plate 17, Part II.

MUNICIPAL CENTRAL STATIONS.

Total primary power.—The total primary power in municipal central stations in 1912 was 559,328 horsepower or 12 per cent of that in commercial central stations. Of this total, 23.5 per cent was water power, 72.5 per cent steam power, and 4 per cent gas power. The percentages of steam power and of gas power are greater and of water power less than in commercial stations. The upper Mississippi Valley leads in municipal power development, although Washington has the largest installation of any single State. The highest rate of increase in municipal power development is found in the Mountain and Pacific States, the former increasing 1,960 per cent and the latter 2,280 per cent in the 10 years from 1902 to 1912.

The percentage increases by periods for the several geographic divisions are shown in the following table. Detailed figures for the several States are given in Table No. 13 and on plate 20, Part II.

TABLE No. 13.—Percentage increase in primary power, municipal central stations, by geographic divisions.

	1902-1912	1902-1907	1907-1912
New England.....	302	150	61
Middle Atlantic.....	108	84	13
East North Central.....	139	62	48
West North Central.....	209	98	56
South Atlantic.....	438	194	83
East South Central.....	289	154	49
West South Central.....	526	143	158
Mountain.....	1,960	774	136
Pacific.....	2,280	272	540
United States.....	250	101	74

Primary power per thousand of population.—In proportion to population the State of Washington had in 1912 more than twice as much municipal power as any other State, or 44.9 horsepower per thousand. Florida is second, with 21.4 horsepower, and Vermont third, with 18.9 horsepower. But three other States—Indiana, Michigan, and Utah—have more than 10 horsepower per thousand of population. By groups the Pacific States lead, having nearly three times the average for the United States.

Amounts by geographic division for three census years are given in the following table. Detailed figures for the several States may be found in Table No. 18 and plate 21, Part II.

TABLE No. 14.—Primary power per thousand of population, municipal central stations, by geographic divisions, in horsepower.

	1912	1907	1902
New England.....	6.8	4.6	2.0
Middle Atlantic.....	1.6	1.5	.9
East North Central.....	9.6	6.9	4.6
West North Central.....	7.1	4.8	2.6
South Atlantic.....	5.3	3.1	1.1
East South Central.....	4.2	3.0	1.2
West South Central.....	3.4	1.5	.7
Mountain.....	3.6	1.8	.3
Pacific.....	15.7	3.0	1.1
United States.....	5.9	3.7	2.0

Water power.—The total amount of water power developed by municipal stations in 1912 was 130,261 horsepower or only 5.5 per cent of the amount developed in commercial stations. Forty-four per cent of the total for the United States, or 57,235 horsepower, was in the one State of Washington, and 65 per cent in the two States of Washington and Illinois. By geographic divisions the Pacific States lead with 62,979 horsepower, followed by the East North Central States with 39,762 horsepower. These two groups have 79 per cent of the total for the United States.

Detailed figures by States are given in Table No. 13 and on plate 17, Part II.

Steam power.—The installation in municipal stations aggregated 406,666 horsepower in 1912, more than three times the water-power installation. With the exception of Illinois, with its municipal developments on the Chicago Drainage Canal, the States of the upper Mis-

issippi Valley, where the greatest municipal development is found, depend almost entirely upon steam power. In the Pacific States, on the other hand, steam power is but little used, amounting to only one-eighth of the total. In Washington, which has the highest municipal development of any single State, water power furnishes over 99 per cent of the total installation.

Gas power.—Although increasing more than 2.5 times in the five years 1907 to 1912, gas power afforded in 1912 but 4 per cent of the total installation in municipal stations. More than one-half of the total for the United States is found in the two North Central groups of States.

STREET AND ELECTRIC RAILWAYS.

As stated hitherto on page 20 the census statistics for street and electric railways are not always clearly distinguished from those for commercial central stations. This is particularly true of the States of Washington and Oregon. The statistics for street and electric railways also include electrically operated divisions of steam roads, but "only in cases where full reports could be made therefor separately from those for the steam railroad operations."

"Some companies reported the same tracks as operated by both steam and electricity and others that the traffic and operating statistics of an electrically operated branch did not permit of segregation from those pertaining to the main line operated by steam. Statistics for these roads are therefore not included in the general statistics for electric railways. There are also excluded from the general statistics the Chicago Tunnel Co., operating the system of narrow-gauge freight tunnels under the streets of Chicago, the Bingham Central Railway of Utah, a narrow-gauge electric tunnel road serving mines, and the road owned by the State of North Dakota, at Bismarck, and operated in connection with the State capital."

Total primary power—steam, water, and gas power—operated by street and electric railway companies in 1912 aggregated 3,665,051 horsepower, slightly over one-half the amount operated by commercial central stations. Of the total in 1912, 12.8 per cent was water power, 86.5 per cent steam power, and 0.6 per cent gas power. New York leads with 655,720 horsepower, nearly twice as much as the next largest, Ohio, with 333,075 horsepower. Only three other States—Pennsylvania, Massachusetts, and Washington—have over 200,000 horsepower, and Washington's total contains a considerable amount that should have been credited to commercial central stations. The two leading groups of States are the Middle Atlantic and the East North Central, the former with 977,703 horsepower and the latter with 824,707 horsepower. The Pacific group, with 388,578 horsepower, is too large on account of the inclusion of central-station power in Washington and Oregon. This inclusion also affects the total for the United States. Five States—South Dakota, Idaho, Wyoming, New Mexico, and Nevada—reported no stations operated by electric railway companies in 1912, the power being purchased from central stations.

The percentages of increase by geographic divisions are given in the following table. Details for the several States may be found in Table No. 14 and on plate 22, Part II.

¹ Central electric stations and street and electric railways, 1912, Bureau of the Census, p. 179.

TABLE NO. 15.—Percentages of increase in primary power, street and electric railways, by geographic divisions.

	1902-1912	1902-1907	1907-1912
New England.....	112	52	39
Middle Atlantic.....	138	97	21
East North Central.....	117	67	30
West North Central.....	183	69	68
South Atlantic.....	222	116	49
East South Central.....	226	150	31
West South Central.....	377	218	50
Mountain.....	616	183	153
Pacific.....	¹ 580	81	¹ 284
United States.....	¹ 170	85	¹ 45

¹ These percentages are somewhat too large on account of the inclusion by the Bureau of the Census of a considerable amount of commercial central station power as electric railway power in the States of Oregon and Washington in 1912.

Primary power per thousand of population.—In proportion to population the three States of Washington, Oregon, and Utah lead all others, with 191.7 horsepower, 149.8 horsepower, and 104.5 horsepower per thousand of population. Both Washington and Oregon, and probably Utah, are too high on account of the inclusion of certain amounts of commercial central station power in the electric railway figures. These States, however, would undoubtedly lead, even with corrected figures.

Detailed figures for the several States are given in Table No. 18 and on plate 22, Part II. Totals for the geographic divisions are given in the following table:

TABLE NO. 16.—Primary power per thousand of population, street and electric railways, by geographic divisions, in horsepower.

	1912	1907	1902
New England.....	62.3	48.2	34.3
Middle Atlantic.....	48.4	44.4	25.2
East North Central.....	44.0	36.1	23.1
West North Central.....	27.5	17.3	10.9
South Atlantic.....	30.4	22.0	11.0
East South Central.....	16.1	13.0	5.5
West South Central.....	12.0	9.1	3.3
Mountain.....	32.3	15.4	6.8
Pacific.....	¹ 84.7	28.1	20.5
United States.....	¹ 38.4	28.8	17.1

¹ These amounts are somewhat too large on account of the inclusion by the Bureau of the Census of a considerable amount of commercial central station power as electric railway power in the States of Oregon and Washington in 1912.

Water power.—The total water-power installation in street and electric railway stations 1912 was 471,307 horsepower, or 12.8 per cent of the total primary power installation. The use of water power has, however, increased rapidly in recent years. The census reports show an increase of 87 per cent from 1902 to 1907 of 412 per cent from 1907 to 1912; and of 858 per cent from 1902 to 1912. Although the last two percentages are somewhat high on account of the inclusion of commercial central station power as above stated, they show, when compared with the corresponding percentages of total power increase—45 per cent, 85 per cent, and 170 per cent—percentages which are similarly affected, a far more rapid increase in the use of water power than in other sources of primary power for electric railway operation. This increase is most marked in the Mountain and Pacific groups of States, particularly the latter.

With the exception of Minnesota, three groups of States, the West North Central, the East South Central, and the West South Central, had no water power in electric railway stations in 1912. Two hundred and eighty-eight thousand eight hundred and eighty-five horsepower or over 61 per cent of the total water power re-

ported to the census in 1912 was in six of the Western States included in the Pacific and Mountain groups; 26 of the 48 States reported no water power.

Steam power.—The installation of steam power in electric railway stations aggregated 3,169,554 horsepower in 1912, or 86.5 per cent of the total primary power in such stations. In steam installation New York leads with 634,490 horsepower or nearly twice as much as the next State, Ohio, which had 330,995 horsepower. In all sections except the Pacific States, steam furnishes by far the largest part of the power. Only in the Pacific group is water the chief source of primary power.

Gas power.—This plays an unimportant part in electric railway operation, being less than 1 per cent of the total primary power. Only 12 States in 1912 reported any gas power installation. The largest in any State was 4,660 horsepower in Pennsylvania.*

COMMERCIAL AND MUNICIPAL CENTRAL STATIONS AND STREET AND ELECTRIC RAILWAYS.

The clearest understanding of the trend of electric-power development can be had from a consideration of the combined primary power installations of the commercial central stations, the municipal central stations and the street and electric railways. While a certain amount of electric power is developed by manufacturing establishments for use in such establishments, the three uses above named comprise what is generally considered as the electric power industry.

Total primary power.—The total of steam, water, and gas power used by central stations and electric railways in 1912 aggregated 11,193,699 horsepower, or 36.8 per cent of all the primary power used for all purposes in the United States. Of this amount 26.3 per cent was water power, 72.5 per cent steam power, and 1.2 per cent gas power. New York leads in total installation with 1,813,529 horsepower, followed by Pennsylvania with 908,879 horsepower and California with 881,559 horsepower. Five of the nine groups of States had over a million horsepower. The Middle Atlantic and east North Central States lead with 2,991,020 horsepower and 2,515,706 horsepower, respectively. The Pacific States are third with 1,378,725 horsepower.

In rate of increase in electric power development the Western States lead all others. The average rate of increase for the 11 States in the Mountain and Pacific groups for the 10 years 1902 to 1912 was 44 per cent per year, or 440 per cent for the 10-year period. The increase for the remainder of the United States during the same period was 226 per cent, or slightly more than one-half the rate of increase of the Western States. Electric power development in the 17 Eastern States comprised within New England, Middle Atlantic, and South Atlantic States during the same period was 215 per cent, or less than one-half the rate of increase for the Western States. The most significant fact to be deduced from the census statistics of the electric power industry is the remarkable power development of the Western States, particularly of the Pacific group, as evidenced in a rate of increase in the Western States nearly twice as great as for the remainder of the United States, and for the Pacific group of two and one-fifth times as great. This rate of increase of western power development is still more strikingly apparent when the intensity of development in proportion to population is considered

The rates of increase for the several geographic divisions are given in the following table and diagram (Plate VII). Details for the several States are given in Table No. 17, Part II, and on plate 24, Part II.

TABLE No. 17.—Percentages of increase in primary power, commercial and municipal central stations, and street and electric railways, by geographic divisions.

	1902-1912	1902-1907	1907-1912
New England.....	160	62	61
Middle Atlantic.....	205	97	55
East North Central.....	228	92	71
West North Central.....	244	114	61
South Atlantic.....	375	161	82
East South Central.....	261	124	62
West South Central.....	306	143	67
Mountain.....	340	122	98
Pacific.....	492	193	102
United States.....	246	106	66

Primary power per thousand of population.—In intensity of electric-power development per capita the commanding position of the Western States is even more apparent than when merely rate of increase is considered. The first six States in order of electric power per capita in 1912 are Western States—California, Montana, Washington, Utah, Colorado, and Oregon in the order named. California, with 342 horsepower per thousand of population, had more than 2.5 times the average for the United States. Only one State outside of the two western groups had a development in excess of 200 horsepower per thousand, and this was New Hampshire, with 203.2 horsepower. The Pacific group, with an average of 300.5 horsepower, has nearly twice as much as the highest group outside of the Western States—New England, with its average of 170.9 horsepower. The development in the 11 Western States included in the Pacific and Mountain group was 255.1 horsepower per thousand, or 2.5 times as much as in the remainder of the United States (105.5 horsepower) and nearly twice as much as in the three eastern groups (130.4 horsepower) of New England, Middle Atlantic, and South Atlantic States.

Amounts per thousand of population in the several geographic divisions appear in the following table and diagram (Plate VIII). Details for the several States are given in Table No. 19 and on plate 25, Part II.

TABLE No. 18.—Primary power per thousand of population, commercial and municipal central stations and street and electric railways, by geographic divisions, in horsepower.

	1912	1907	1902
New England.....	170.9	114.4	77.0
Middle Atlantic.....	148.2	105.8	60.1
East North Central.....	134.1	83.7	46.5
West North Central.....	78.0	51.2	25.4
South Atlantic.....	79.7	47.2	19.5
East South Central.....	41.2	26.8	12.7
West South Central.....	37.1	25.3	12.1
Mountain.....	182.2	110.8	63.0
Pacific.....	300.5	181.9	83.4
United States.....	117.3	75.7	40.3

Water power.—The aggregate water-power installation in central stations and electric railways was 2,942,388 horsepower in 1912, or 26.3 per cent of the total primary power employed for such purposes. From 1902 to 1907 water-power installation increased 953,423 horsepower, or 195 per cent; from 1907 to 1912,

1,501,340 horsepower, or 104 per cent; and from 1902 to 1912, 2,451,763 horsepower, or 502 per cent. A comparison of these percentages with the corresponding increase in total primary power of 106 per cent, 66 per cent, and 246 per cent, shows a much more rapid development of water power than of other sources of power in the electrical industry.

In total water-power installation New York again leads with 530,921 horsepower, followed by California with 432,327 horsepower and Washington with 269,641 horsepower. Six other States, South Carolina, Michigan, Pennsylvania, Oregon, Montana, and Minnesota, had more than 100,000 horsepower. By geographic divisions the Pacific States lead with 807,270 horsepower, followed by the Middle Atlantic States with 665,508 horsepower. The ratio of water power to total power is the highest in the Mountain States, 65 per cent, and in the Pacific States, 58.5 per cent, both having more than twice the average percentage for the United States.

Steam power.—Steam power formed 72.5 per cent of the total primary power operated by central stations and electric railways in 1912, or 2.75 times the water-power installation. This preponderance of steam power is mainly found in the Eastern States where two groups, the Middle Atlantic and the East North Central States, have more than one-half of the total for the United States. In but two groups, the Mountain and the Pacific, is there less steam power than water power.

The total steam installations of the central stations and electric railways in the United States in 1912 was 8,116,086 horsepower, or one-third of the total steam power for all purposes estimated and reported for the year. Among the individual States, New York leads with 1,273,422 horsepower, more than one-sixth of the total in the United States and over a half million horsepower in excess of its nearest competitor, Pennsylvania.

Gas power.—Gas power forms 1.2 per cent of the total primary power in central stations and electric railways, the installation in 1912 being only 135,225 horsepower for the United States. Nearly one-half the total is found in the five States of Kansas, Ohio, Oklahoma, Pennsylvania, and Texas.

MANUFACTURES.

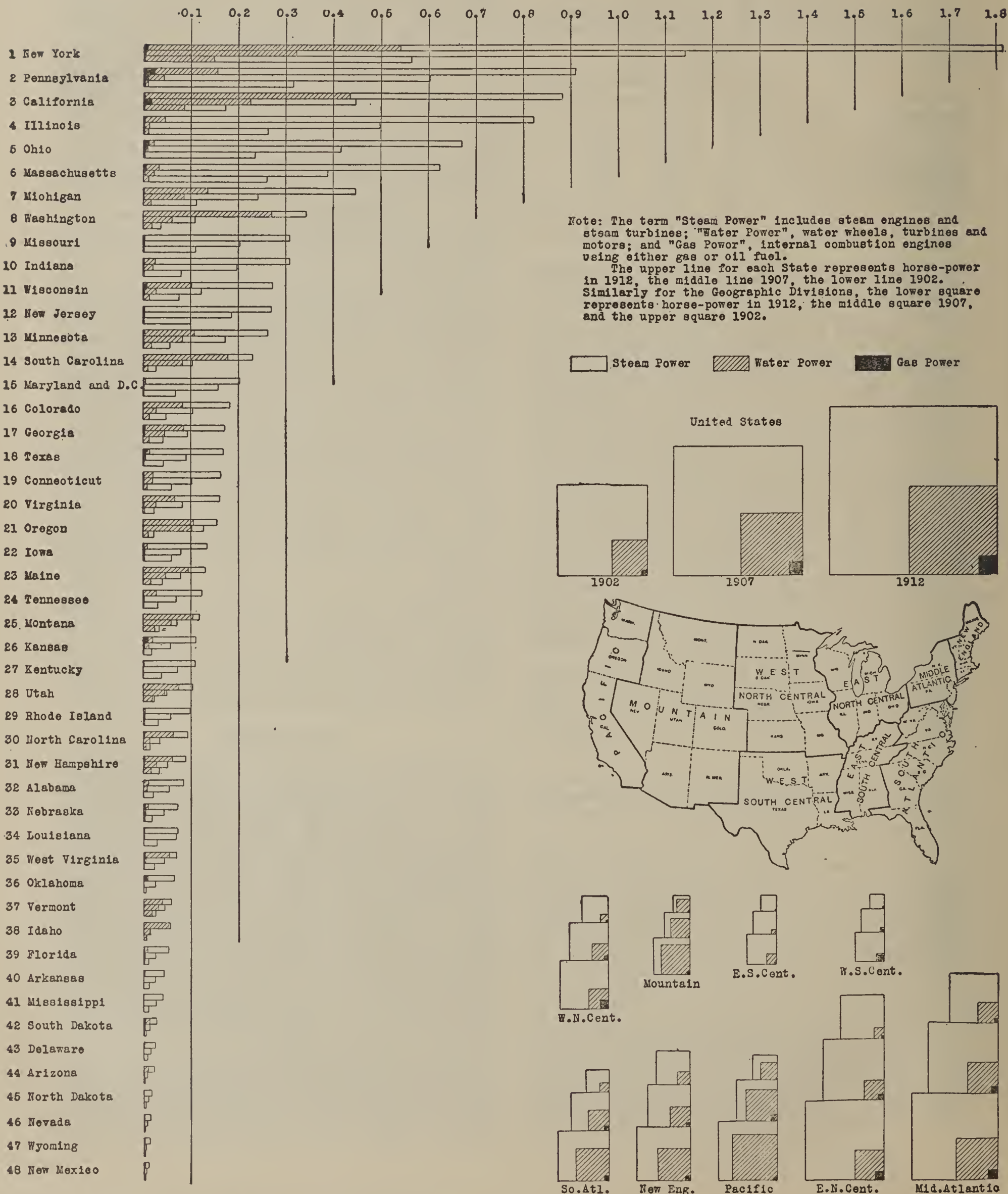
The Bureau of the Census collected statistics for power used in manufactures by 10-year intervals from 1869 to 1899 and by 5-year intervals since the latter date. As the data for central stations and electric railways and for manufactures are not collected in the same years, they are not directly comparable. For the purposes of this report, however, the power used in manufactures has been estimated for the years 1902, 1907, and 1912 from the census reports of 1899, 1904, and 1909 by assuming a uniform rate of increase from 1899 to 1904 and from 1904 through 1909 to 1912. While figures thus obtained can be considered only approximate, the short intervals between the reports should make the estimates reasonably accurate and should afford a fair basis of comparison with the power used in the electrical industry.

Primary power in manufactures, as the term is used in this report, comprises only "prime movers"—steam engines and turbines, water wheels and turbines, and gas engines—owned by the manufacturing establishments and used therein. The Bureau of the Census

CENTRAL STATIONS AND STREET AND ELECTRIC RAILWAYS

PLATE VII

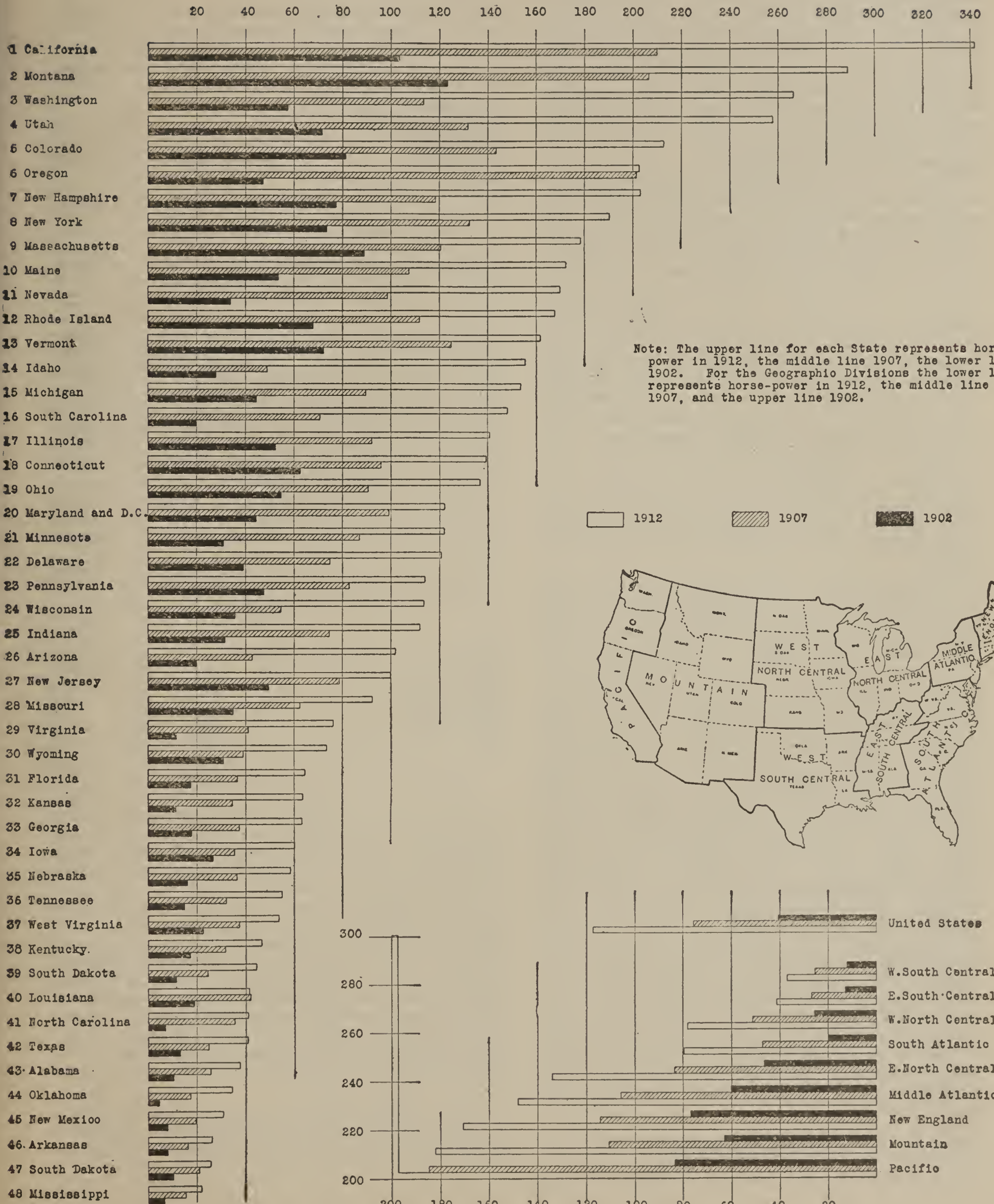
Primary Power in 1912, 1907 and 1902: - Steam Power, Water Power, and Gas Power
By States and by Geographic Divisions
In Millions of Horse-Power



COMMERCIAL AND MUNICIPAL CENTRAL STATIONS AND STREET AND ELECTRIC RAILWAYS

PLATE VIII

Primary Power Per Thousand of Population in 1912, 1907 and 1902
By States and by Geographic Divisions
In Horse-Power



for the purposes of its report adds also "the power of electric motors run by purchased current and any other power that may be purchased or rented from outside concerns."¹

Manifestly, if the primary power in manufactures as defined by the Bureau of the Census should be added to primary power in central stations and electrical railways, the sum would be greater than the total primary power in the United States, for there would be duplication to the extent of the capacity of electric motors operated by the purchased power, plus any other power purchased or rented. Since this report deals with total power development, the data for prime movers only have been used.

While a considerable although unknown amount of electric power is developed in manufacturing establishments for use therein, by far the greater part of the primary power of such establishments is used directly without conversion into electricity. The census reports do not show the amount of primary power employed in the generation of electricity in manufacturing plants. It probably would be difficult if not impossible to segregate the power used to drive generators from the power used for other purposes in such establishments. The installed capacity of electric motors driven by "owned power" in manufacturing establishments was reported to the census as 3,000,000 horsepower in 1899. What relation primary power bears to motor installation is wholly indeterminate. It is probably, however, much less than the rated motor installation. While primary power in manufacturing plants is not important in a consideration of the electrical industry, data concerning it are of interest as showing the volume of power utilized in manufactures and the grand total of power development for all uses.

Total primary power.—Estimated as explained above, the aggregate primary power employed directly in manufactures was 19,254,547 horsepower in 1912, or 63.2 per cent of the total primary power used for all purposes in the United States. Of this amount 10 per cent was water power, 84.4 per cent steam power, and 5.6 per cent gas power. In total estimated power developed in manufacturing plants Pennsylvania, with 3,081,463 horsepower, is far ahead of any other State. But four other States—Ohio, New York, Massachusetts, and Illinois, in the order named—had more than 1,000,000 horsepower each. These five States had nearly one-half (45.4 per cent) of the total within the United States. The Middle Atlantic group of States leads in installation, followed by the East North Central and the New England States. These three groups had in 1912 an estimated combined installation of 12,800,000 horsepower, or two-thirds of the total in the United States. Although the total amount of primary power in manufacturing establishments in the Western States was a little less than 1,200,000 horsepower in 1912, or 6.1 per cent of the total for the United States, these States have shown the most rapid rate of increase of any section of the country, advancing 67 per cent from 1902 to 1907, 41 per cent from 1907 to 1912, and 121 per cent from 1902 to 1912, or nearly twice as rapidly as for the United States as a whole, for which the corresponding percentages were 30 per cent, 25 per cent, and 63 per cent, respectively.

Percentages of increase by geographic divisions appear in the following table. Detailed figures for the several States may be found in Table No. 15, and on plate 26, Part II.

TABLE No. 19.—Percentage of increase in primary power in manufacturing plants, by geographic divisions.

	1902-1912	1902-1907	1907-1912
New England.....	93	20	18
Middle Atlantic.....	48	25	18
East North Central.....	66	31	27
West North Central.....	72	32	30
South Atlantic.....	84	40	32
East South Central.....	76	38	23
West South Central.....	110	49	41
Mountain.....	113	58	36
Pacific.....	125	57	43
United States.....	63	30	25

Primary power per thousand of population.—In proportion to population the New England States lead in amount of primary power in manufacturing plants, followed in order by the Middle Atlantic, the East North Central, and the Pacific States. New Hampshire leads the individual States with 709.4 horsepower per thousand of population, followed by Maine with 651.3 horsepower, Vermont with 426 horsepower, and Rhode Island with 415 horsepower. The highest figure outside of New England is 386.7 horsepower for Pennsylvania. Among the Western States Oregon leads with 287.9 horsepower, followed by Washington with 259.8 horsepower per thousand of population.

Figures for the several geographic divisions are given in the following table. Details for the individual States may be found in Table No. 18 and on plate 27, Part II.

TABLE No. 20.—Primary power per thousand of population in manufacturing plants, by geographic divisions, in horsepower.

	1912	1907	1902
New England.....	406.9	370.1	335.5
Middle Atlantic.....	271.1	253.7	227.0
East North Central.....	244.9	205.2	167.9
West North Central.....	96.1	78.1	63.0
South Atlantic.....	154.3	125.9	97.5
East South Central.....	133.6	109.9	84.3
West South Central.....	109.6	88.8	69.3
Mountain.....	139.1	123.7	98.8
Pacific.....	170.2	147.9	124.2
United States.....	201.6	175.7	148.6

Water power.—The water power in manufactures in 1912 furnished only 10 per cent of the primary power, or a total of 1,927,932 horsepower. This was, however, nearly 40 per cent of the total developed water power in the United States.

Of the water power used in manufactures the New England and Middle Atlantic States have 65 per cent. New York leads with 365,308 horsepower, or nearly one-fifth of the total in the United States, followed by Maine, with 291,571 horsepower. The 11 Western States had only 105,017 water horsepower used directly in manufactures. This is due to the fact that power for manufacturing purposes in the West is largely purchased from commercial electric companies.

Detailed figures by States are given in Table No. 15 and on plate 8, Part II.

Steam power.—The steam power installation in manufacturing plants was estimated as 16,223,733 horsepower in 1912, or 84.4 per cent of the total power

¹ Thirteenth Census of the United States, 1910, vol. 8, Manufactures, General Report and Analysis, Bureau of the Census, 1913, p. 330.

developed in such plants. The rate of increase for steam power in manufactures is much greater than for water power. For all other uses, however, water power had increased more rapidly than steam power. In manufacturing plants such power as is developed by the manufacturer for his own use is developed at the site of the manufacturing plant, and the most extensive manufactures are in the great centers of population where water power is not available. A constantly increasing amount of power is being purchased and used in manufacturing operations, but the prime movers developing such power are classed with central stations and not with manufactures.

Of the individual States Pennsylvania is estimated to have had the largest steam installation in manufacturing plants in 1912, or 2,812,523 horsepower, 18 per cent of the total for the United States and nearly twice as much as the next highest State, Ohio. These two States, together with New York, had an es-

timated steam installation in 1912 of 5,593,843 horsepower, or more than a third of the total for the United States. The 11 Pacific and Mountain States combined had less steam installation in manufacturing plants than the lowest of the three States named above.

Detailed figures for the several States may be found in Table No. 15 and on plate 26, Part II.

Gas power.—Eighty-nine per cent of the gas power estimated and gas power formed but 5.6 per cent of the total power so used. The reported for 1912 was installed in manufacturing plants, although estimated total gas power in manufactures in 1912 was 1,102,882 horsepower. Pennsylvania leads with an estimated installation of 211,002 horsepower in 1912. This State, together with Indiana, Ohio, and New York, had 60 per cent of the estimated gas power developed in manufacturing plants in 1912.

Details for the several States may be found in Table No. 15 and on plate 15, Part II.

POWER DEVELOPMENTS IN 1915.

The reports of the Bureau of the Census bring the data on power development up to 1912. In order to determine the amount of development since that date, both in the aggregate and by individual plants, a census has been made of power installation in 1915 in commercial and municipal central stations and street and electric railways. Data have also been secured for some of the larger manufacturing plants, but no attempt has been made to have this data complete. In making this census all available information in such directories as McGraw's Electrical Directory, McGraw's Electric Railway Directory, Moody's Manual of Railroad and Corporation Securities, Poor's Manual of Public Utilities, reports of the public utility commissions of the several States, and engineering periodicals has been secured and tabulated, and then supplemented and corrected, for the Western States, by the field investigation of the district engineers of the Forest Service, and in the remainder of the United States by correspondence with the operating companies. While there are doubtless omissions in the data, it is believed that the information concerning public-utility plants in the Western States is substantially correct. The data for the remainder of the United States have not been verified by field examinations, but for approximately one-half of the stations listed have been verified or corrected by the officials of the power companies. How much error may exist in the data for the remainder of the stations is uncertain. All available sources of information, however, have been utilized in order to secure the greatest possible accuracy.

In addition to data on installation information has also been secured, when possible, concerning the markets supplied, the location of the plants, the stream utilized (if water power), and the rates charged for lighting and for power. Lists by States of the companies and plants for which information has been secured, giving in horsepower the installation of water wheels, boilers, steam engines and gas engines, and the kilovolt-ampere rating of generators may be found in detail in Table No. 55, Part II, and summarized in Tables Nos. 53 and 54, Part II.

Those States in which it has been possible to secure reasonably complete data show a considerable increase in development of all sources of power since the date (1912) of the statistics collected by the Bureau of the Census. The increase is most marked in the Western States, particularly in the Pacific group, where the rate

of increase in development since 1912 has been still more rapid than in the five years from 1907 to 1912. These later data serve to give added emphasis to the conclusions drawn from the public statistics of the Bureau of the Census.

RELATION OF WATER-POWER DEVELOPMENT TO TOTAL POWER DEVELOPMENT.

Although water power in 1912 amounted to only 16 per cent of the total power from all sources, the rate of increase for the 10 years, 1902 to 1912, was 137 per cent as compared with 96 per cent for steam power, which is the source of 80 per cent of the total primary power. The large proportion of steam power is due to the fact that the States which have the largest population, the highest development of manufactures, and consequently the greatest amounts of developed power, are situated either in sections having no water power or in sections supplied with cheap fuel.

In seven of the nine geographic divisions—the Pacific and Mountain groups alone excepted—the total primary power installed in 1912 was in excess of the estimated minimum potential water-power resources of the section, and in five out of the seven in excess of the maximum resources without storage. It would not be safe to assume that in the existing state of the art it would be possible, by the development of all practicable storage and by ignoring questions of cost, to make practically available for use more water power than is represented by the maximum potential power estimates given in this report; nor if questions of cost are given proper weight, much in excess of the minimum estimates. Five great groups of States, the New England, the Middle Atlantic, the East North Central, the West North Central, and the West South Central, having in 1912 a population of 67,000,000, or 70 per cent of the total for the United States, had already installed a primary power equipment—water, steam, and gas—of 14½ million horsepower, or 171 per cent, in excess of their maximum water-power resources; and two other groups, the South Atlantic and East South Central, had exceeded their minimum resources. Out of the seven groups, 23 individual States had already installed in 1912 primary power equipment in excess of their maximum water-power resources, and 29 States in excess of their minimum resources. In these seven groups the aggregate primary power in 1912 was more than three and a half times (3.53) the minimum and

nearly twice (1.87) the maximum combined water-power resources of the groups. Under such circumstances it is idle to assume that water power can wholly supersede steam power over the greater part of the United States under any conditions now known, or, as power developments continue to increase in the future, can play more than a minor rôle as a primary source of power. While it would be rash to attempt to predict the future or to set limits to the distance to which it may be possible eventually to transmit electric power, yet until the time shall have come, if it ever comes, when the enormous power resources of the Western States can be developed and transmitted into the States of the Mississippi Valley and along the Atlantic coast, the greater part of the United States will be forced to rely for the larger part of its power on sources other than water power.

While 6 of the 23 States in which total primary power is in excess of maximum water-power resources had in 1912 developed their water power to a point in excess of their minimum estimated resources, and one State, Rhode Island, in excess of its maximum estimate, there is still a large amount of water power which under favorable conditions might be utilized. But not all water powers, even those which make up the estimate of minimum resources, can in centers of cheap fuel compete with steam power either in point of cost or in point of reliability. Furthermore, even though when developed, the unit cost of current in a water-power plant may be less than in a steam plant, the higher capital cost of the water-power plant serves as a deterrent to its development unless a considerable margin of saving can be assured. Economic considerations of cost, of risk, of reliability of service, and of distance from market determine whether water power or steam power shall be used if both are available.

Although steam was the primary source of 80 per cent of the power in the United States in 1912, in all but two groups of States, the New England and Middle Atlantic, the development of water power increased more rapidly from 1902 to 1912 than the development of steam power, the respective percentages being 137 per cent and 96 per cent. The higher rate of increase for water power is most marked in the Pacific, Mountain, and South Atlantic States, in the order named.

The relatively greater increase in water power is indicated by the percentages which water power bears to total power for the different census years. In 1902 water power furnished 13.7 per cent of the total power in the United States; in 1907, 14.5 per cent; and in 1912, 16 per cent. The highest percentages in 1912 are found in the Pacific States, 41.2; in the Mountain States, 39.3 per cent; and in the New England States, 27.1 per cent. Among classes of uses the highest proportion of water power in 1912, 33.6 per cent, is found in commercial central stations. Municipal central stations had less than one-fourth (23.5 per cent); street and electric railways one-eighth (12.8 per cent); and manufactures but one-tenth of their total primary power developed from water.

The relative position of the several States in respect to water-power development appears in Table No. 21 and on plates 9, 10, and 11, Part II. A small scale reproduction of plate 9 is given on the following page.

RELATIVE POSITION OF WESTERN STATES IN PRIMARY POWER DEVELOPMENT.

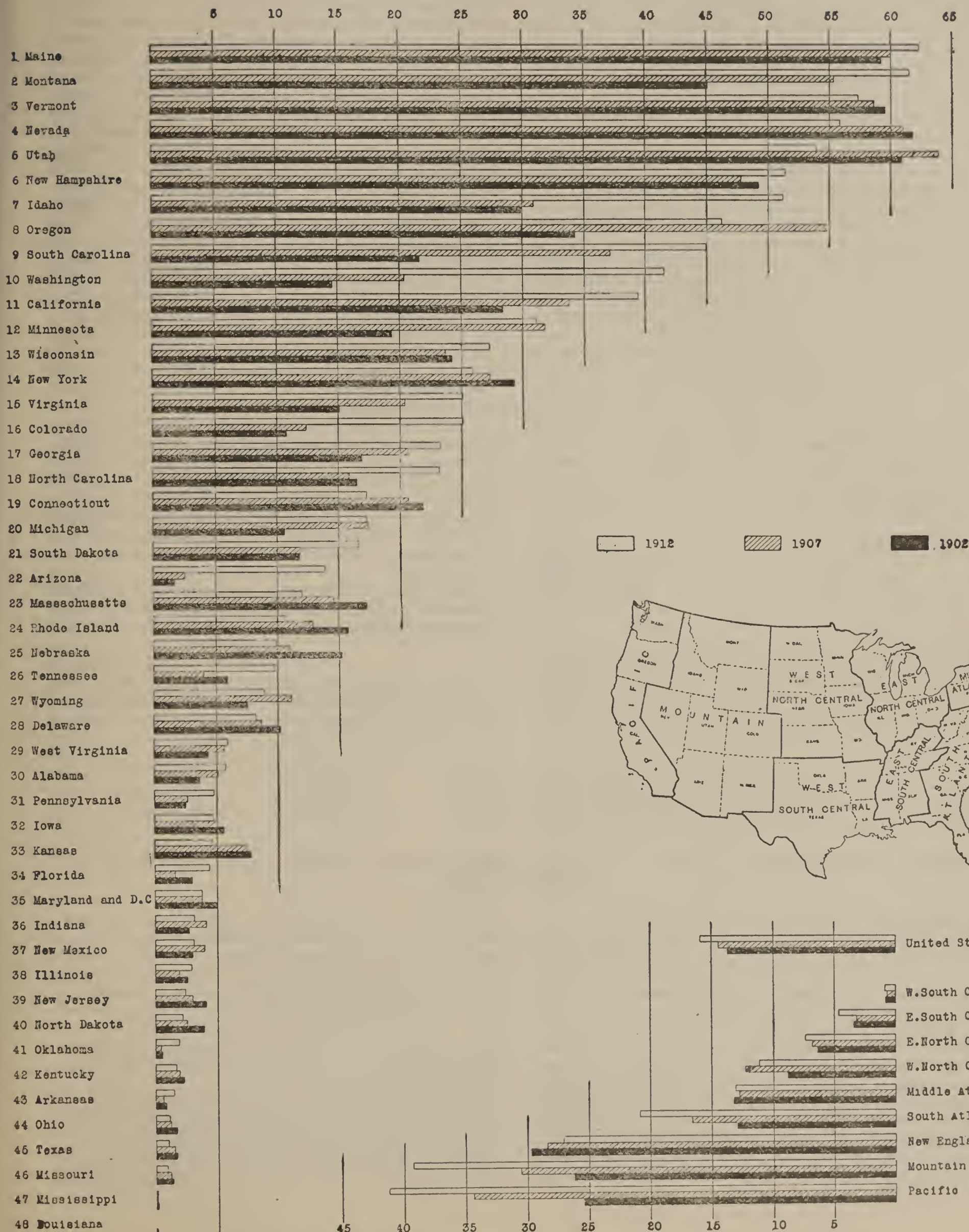
The 11 Western States included within the Pacific and Mountain groups have an area of 1,189,140 square miles, 39.3 per cent of the total area of the United States. These States in 1902 had a population of 4,668,000, or 5.9 per cent of the total for the United States. The same percentage represents the ratio of total primary power in the Western States to that of the United States as a whole, for the per capita development of the Western States and of the United States was identical in 1902, at 189 horsepower per thousand of population. From 1902 to 1912 the population of the Western States increased 59 per cent, or nearly four times (3.81) as fast as in the remainder of the United States, the increase in which was 15.5 per cent. Primary-power installation in the meantime increased 248 per cent in the Western States, or more than two and one-half times (2.64) as rapidly as in the remainder of the United States, for which the increase was 94 per cent. In primary-power equipment per thousand of population the Western States show an increase from 189.1 horsepower in 1902 to 413.4 in 1912; the remainder of the United States an increase from 190 horsepower to 310.7 horsepower. While the remainder of the United States in the 10 years from 1902 to 1912 added 120.7 horsepower per thousand to its primary-power installation, the Western States added 224.3 horsepower, or nearly twice as much, and had a total installation per thousand of population one-third greater than for the remainder of the United States.

The figures given above include primary power used directly in manufactures, 94 per cent of which is found in the Central and Eastern States. If comparison is made of the development of electric power in the Western States and in the remainder of the United States, it is found that while the primary power employed in the electrical industry increased 226 per cent in the remainder of the United States, it increased 440 per cent in the Western States, or nearly twice as rapidly. In the three eastern groups of States the increase was but 215 per cent, or less than one-half that of Western States. In electric-power development per thousand of population the Western States had 255.1 horsepower in 1912, or two and a half times as much as the remainder of the United States (105.5 horsepower). In installation per thousand of population in the electrical industry the Western States had 75.2 horsepower in 1902 and 255.1 horsepower in 1912; the remainder of the United States had 38.2 horsepower in 1902 and 105.5 horsepower in 1912. While the remainder of the United States in the 10-year period added 67.2 horsepower per thousand of population to its electric-power installation, the Western States added 179.9 horsepower, or nearly three times as much, and had a per capita installation at the end of the period nearly two and one-half (2.42) times as great as for the remainder of the United States.

If water power be considered apart from all other sources of power, the Western States are found to occupy a still more commanding position. While water-power development in the remainder of the United States increased 98 per cent from 1902 to 1912, it in-

RATIO OF WATER POWER TO TOTAL PRIMARY POWER IN 1912, 1907 AND 1902

PLATE IX

By States and by Geographic Divisions
In Per Cent of Total Power

creased 451 per cent in the Western States, or more than four and a half times as rapidly. In the three eastern groups of States the increase was 86 per cent, less than one-fifth as much as for the Western States. In installed water power per thousand of population the Western States had 48.5 horsepower in 1902 and 167.9 horsepower in 1912; the remainder of the United States had 24.5 horsepower in 1902 and 41.1 horsepower in 1912. While the remainder of the United States in the 10-year period added 16.6 horsepower to its water-power installation per thousand of population, the Western States added 119.4 horsepower, or over seven times (7.18) as much, and had at the end of the period a per capita installation of more than four times (4.08) as much as the remainder of the United States.

Whether power development in general, from all sources, in all forms, and for all uses, be considered, or that part of the Nation's developed power which is employed in the electrical industry, or only that part which is developed from falling water, the census data show that in rate of increase and in intensity of development per capita the Western States have led all other sections.

An examination of the data collected since the census of 1912 shows that the Western States are still maintaining their commanding position in power development. Primary power installation in the Western States in 1915 in the electrical industry, for which alone data have been collected, aggregates 2,784,000 horsepower, as compared with 1,897,000 horsepower in 1912, an increase of 887,000 horsepower, or nearly 47 per cent, in three years. This is an average increase of 296,000 horsepower per year as compared with 191,000 horsepower per year for the five years 1907 to 1912. Of the total increase, 74 per cent, or 661,000 horsepower, is water power, with an average annual increase of 220,000 horsepower as compared with 125,000 horsepower from 1907 to 1912. Twenty-six per cent of the total, or 226,000 horsepower, is steam power. This has increased at a rate of 75,000 horsepower per year as compared with 68,500 horsepower for the five years preceding 1912. As far as information is available the increase of gas-power installation in the Western States since 1912 for the purpose of electric generation of power has been only 249 horsepower.

While the use of electric power for all purposes except manufactures is greater in the Western States than in any other section of the country, as will appear from a later consideration of electric power out-

put, and this greater use explains in large degree the extent of primary power installation, there is also at the present time a considerable overdevelopment in nearly all the power centers of the Western States. In California, for example, where the installation in commercial central stations was over a million horsepower, the sum of the peak loads of the individual plants in 1914 was only slightly over 700,000 horsepower. The sum of the simultaneous peaks on the several power systems probably did not exceed 600,000 horsepower. If so, there was in commercial central stations in California in 1914 an installation of 400,000 horsepower in excess of all demands. A certain amount of surplus installation is always needed to insure against accident and to anticipate increases in market demand, but 67 per cent is far more than is necessary for this purpose. An allowance of one-third, which should be all that is necessary, would still leave 200,000 horsepower unused or but partially used while awaiting increase in markets. In Oregon and Washington the Portland Railway, Light & Power Co., the Puget Sound Traction, Light & Power Co., and the Washington Water Power Co. have installations largely in excess of current needs. A similar situation exists in Montana, in Colorado, and in Utah. In Utah, since the consolidation of operating plants into the Utah Securities Corporation, the margin of installation over the demands of the consolidated market has resulted in the closing or only partial operation of several of the power plants in the system. While there are doubtless many remote sections where small amounts of power could be used if it could be supplied at a reasonable expense, the Western States in general are overdeveloped at the present time, and the real demand is for more markets rather than for more power.

Details of the development in the several States by classes and by uses may be found in Table No. 55, Part II, and are summarized in Table No. 53, Part II.

MAPS.

Maps showing the location of all power plants and the primary transmission lines, and the location and extent of the national forests in each of the following States, are given in Part II.

Arizona.	Nebraska.	South Dakota.
California.	New Mexico.	Utah.
Colorado.	Nevada.	Washington.
Idaho.	North Dakota.	Wyoming.
Montana.	Oregon.	

POWER DEVELOPMENT ON THE NATIONAL UNITED

The greater part of the vacant public lands of the United States and 97 per cent of that portion reserved for national forests are within the 11 States comprising the Mountain and Pacific groups. Forty-two per cent of the total estimated minimum and 43 per cent of the total estimated maximum water-power resources of these two groups of States are within the national forests. A large percentage of the estimated water-power resources outside of the national forests in these two groups of States pertains to navigable rivers, particularly to the Columbia and to its two chief tributaries, the Clarks Fork and the Snake. While these streams possess enormous power possibilities, the great cost of construction and the difficulties of operation due to the reduction in head which would obtain dur-

FORESTS AND OTHER PUBLIC LAND OF THE STATES.

ing times of annual high water would limit the number of sites which could be developed under present conditions. The national forests, therefore, have a much larger proportion of their power resources which could be economically developed under existing conditions than would appear from the preceding percentages. On this account a continually increasing proportion of new power developments utilize sites within the national forests or other public lands of the United States.

Of the 1,804,360 water horsepower developed in the Western States in 1915, 536,782 horsepower, or 29.8 per cent, is in plants occupying national forest lands with some part—power house, water conduit, or diversion reservoir—of the immediate generating plant.

No plants have been included if nothing more than the transmission line is on the national forest. In addition to the above, hydroelectric plants with a capacity of 218,030 horsepower, or 12.1 per cent, are directly dependent upon storage reservoirs owned by the operating companies or their subsidiaries and constructed on national forest lands. The total of power developments thus utilizing national forest lands amounts to 754,812 horsepower, or 41.9 per cent of the total developed power of the Western States. In addition to this, 172,760 horsepower occupy public lands outside the national forests and 72,000 horsepower are directly dependent upon storage reservoirs occupying such lands, making a total of 244,760 horsepower, or 13.6 per cent of the total developed water horsepower of the Western States. Of the total developed power, therefore, 999,572 horsepower, or 55.5 per cent, is developed in plants which either occupy or are directly dependent upon the use of public lands of the United States, as such occupancy and use is authorized under existing law.

In addition to the operating plants there are now under construction on the national forests hydroelectric plants with an estimated capacity at minimum stream discharge of 122,680 horsepower and a proba-

ble primary power installation of not less than 250,000 horsepower. Outstanding final permits authorizing the occupancy and use of national forest lands for hydroelectric plants, the construction of which has not yet started, aggregate 420,765 horsepower of estimated capacity at minimum stream flow. The total primary power installation in these plants, if constructed, would probably exceed 850,000 horsepower. Preliminary permits, maintaining the priority of the applicant while surveys and investigation are being conducted, aggregate 353,750 horsepower of estimated capacity at minimum stream flow and a probable primary power installation, if constructed, of not less than 700,000 horsepower.

Notwithstanding the somewhat unsatisfactory form of the present law, more than one-half of the existing water-power developments of the Western States are making use to some degree of the public lands of the United States under authority from the Federal Government; an estimated amount of 250,000 horsepower more, equal to one-seventh of the total existing developments, is now under construction upon the national forests, and 1,550,000 horsepower, nearly equal to the existing development, is under permit for future construction.

ELECTRIC POWER GENERATED.

The reports of the Bureau of the Census give the quantities in kilowatt hours of the electric power generated in commercial and municipal central stations and by street and electric railway companies. In order that the figures for output might be compared with those for primary power, they have been reduced to horsepower-years by dividing by 6,535 the number of kilowatt hours in a horsepower-year. No data are given for electric power generated in manufacturing plants and used therein for motor operation. In order, however, to determine the approximate amount of power so used, estimates of the electric power output of manufacturing plants have been made upon the assumption that motor capacities and generator capacities are equal, that the same ratio between power output and generator capacities obtains in manufacturing plants as in central stations and electric railways, and that motor capacities in manufacturing plants increased uniformly from 1899 to 1904 and from 1904 through 1909 to 1912. It is clear that these estimates can be nothing better than rough approximations, and that their use is justified only on account of the complete absence of actual data.

In reporting amounts of power generated the Bureau of the Census does not distinguish between the power generated by steam, water, and gas. While in the larger power systems separate records are ordinarily kept for power generated by water and power generated by steam, it would doubtless be difficult to secure accurate data for all plants, and it apparently has not been attempted by the Bureau of the Census.

TOTAL ELECTRIC POWER GENERATED.

The total amount of electric power generated in commercial and municipal central stations, by street and electric railways, and in manufacturing plants as estimated and reported for 1912 was 3,774,622 horsepower-years. Of this amount 44.6 per cent was generated in commercial central stations, 2.2 per cent in municipal central stations, 24.6 per cent in electric railway stations, and 28.6 per cent in manufacturing plants.

The percentage increases in the power generated by the several classes of stations are as follows:

	1902-1912	1902-1907	1907-1912
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Commercial central stations.....	375	141	97
Municipal central stations.....	175	43	86
Street electric railways.....	168	111	27
Manufacturing plants.....	¹ 418	¹ 194	¹ 76
Total power generated.....	302	138	68

¹ Estimated only. Totals also approximate.

By individual States, New York leads with 645,297 horsepower-years, followed by Pennsylvania with 519,863 horsepower-years, and Illinois with 347,884 horsepower-years. These three States had 40 per cent of the electric power generated in 1912. California was fourth with 281,852 horsepower-years. By geographic divisions, the Middle Atlantic States lead, followed by the East North Central and the Pacific States.

In rate of increase by periods the Pacific States lead, followed by the Mountain States. The use of electric power in these two groups combined increased 690 per cent from 1902 to 1912, as compared with an increase of 270 per cent for the remainder of the United States, and 240 per cent for the three Atlantic coast groups.

The percentages of increase for the several geographic divisions by census periods are given in the following table. Details for the several States may be found in Table No. 22 and on plate 32, Part II.

TABLE No. 21.—Percentage increase in electric power generated, all stations, by geographic divisions.

	1902-1912	1902-1907	1907-1912
New England.....	256	119	63
Middle Atlantic.....	226	112	55
East North Central.....	342	153	71
West North Central.....	250	122	58
South Atlantic.....	317	151	66
East South Central.....	318	150	68
West South Central.....	280	124	73
Mountain.....	466	164	114
Pacific.....	846	338	114
United States.....	302	138	69

TOTAL ELECTRIC POWER GENERATED PER THOUSAND OF POPULATION.

The average amount of electric power generated in the United States in 1912 in central stations, electric railway stations, and manufacturing plants was 39.52 horsepower-years per thousand of population—an increase from 25.62 horsepower-years in 1907 and 11.84 horsepower-years in 1902. In horsepower-years per thousand of population the Pacific States lead with 87.95 horsepower-years, followed in order by the Middle Atlantic States, the Mountain States, and the New England States. By individual States, Montana leads with 143.97 horsepower-years per thousand, or more than three and a half times the average for the United States. Nevada is second with 111.66 horsepower-years, and California third with 109.36 horsepower-years.

The total electric power generated per thousand of population in 1912, 1907, and 1902 was distributed among the several classes of stations as follows:

	1912	1907	1902
	<i>Hp. yr.</i>	<i>Hp. yr.</i>	<i>Hp. yr.</i>
Commercial central stations.....	17.65	9.76	4.46
Municipal central stations.....	.86	.51	.38
Electric railway stations.....	9.71	8.34	4.37
Manufacturing plants.....	11.29	7.00	2.63
Total power generated.....	39.52	25.62	11.84

¹ Total does not check in last place on account of fraction in subtotals.

The total electric power generated per thousand of population for the several geographic divisions for the years 1912, 1907, and 1902 is given in the following table. Details for the several States may be found in Table No. 26 and on plate 33, Part II.

TABLE No. 22.—Electric power generated per thousand of population, all stations, by geographic divisions, in horsepower-years.

	1912	1907	1902
New England.....	55.52	36.77	18.21
Middle Atlantic.....	63.28	45.07	24.00
East North Central.....	49.73	31.01	12.83
West North Central.....	19.61	13.18	6.29
South Atlantic.....	16.38	10.60	4.58
East South Central.....	11.23	7.05	2.99
West South Central.....	8.57	7.56	2.99
Mountain.....	59.30	33.36	15.89
Pacific.....	87.95	50.66	15.27
United States.....	39.52	25.62	11.84

COMMERCIAL CENTRAL STATIONS.

TOTAL ELECTRIC POWER GENERATED.

Electric power generated by commercial central stations in 1912 was 1,685,600 horsepower-years, or 44.6 per cent of the total for all stations. By individual States New York leads with 331,138 horsepower-years, followed by California with 266,515 horsepower-years, Illinois with 160,506 horsepower-years, and Pennsylvania with 149,848 horsepower-years. No other State generated more than 100,000 horsepower-years. By geographic divisions the Middle Atlantic States lead, followed by the East North Central and the Pacific States.

In rate of increase from 1902 to 1912 the Pacific States lead with 884 per cent, followed by the South

Atlantic States with 634 per cent. The Pacific and Mountain groups combined increased 706 per cent for the 10 years, or 2.2 times as rapidly as for the remainder of the United States and more than two and a half times as rapidly as for the three eastern groups of States. The percentages of increase by geographic divisions for the census periods are given in the following table:

TABLE No. 23.—Percentage of increase in electric power generated, commercial central stations, by geographical divisions.

	1902-1912	1902-1907	1907-1912
New England.....	253	90	86
Middle Atlantic.....	251	98	78
East North Central.....	504	154	138
West North Central.....	366	146	90
South Atlantic.....	634	175	167
East South Central.....	211	55	101
West South Central.....	187	71	68
Mountain.....	478	151	122
Pacific.....	884	433	83
United States.....	376	141	97

ELECTRIC POWER GENERATED PER THOUSAND OF POPULATION.

The average of electric power generated in the United States in commercial central stations per thousand of population in 1912 was 17.65 horsepower-years, an increase from 9.76 horsepower-years in 1907 and 4.46 horsepower-years in 1902. On this basis Montana leads with 142.52 horsepower-years, followed by California with 103.41 horsepower-years. The former had more than eight times the average for the United States, the latter nearly six times as much. By geographic divisions the Pacific and Mountain States lead with 61.16 horsepower-years and 45.03 horsepower-years, respectively. These two groups combined had an average of 54.98 horsepower-years, or three and eight-tenths times the average for the remainder of the United States (14.49 horsepower-years), and two and eight-tenths times the average for the Eastern States (19.35 horsepower-years).

Amounts for the several groups of States appear in the following table. Details for the several States may be found in Table No. 25 and on plate 35, Part II.

TABLE No. 24.—Electric power generated per thousand of population, commercial central stations, by geographic divisions, in horsepower-years.

	1912	1907	1902
New England.....	19.03	11.00	6.29
Middle Atlantic.....	26.73	16.69	9.45
East North Central.....	18.63	8.36	3.52
West North Central.....	8.36	4.66	2.02
South Atlantic.....	7.68	3.09	1.22
East South Central.....	3.49	1.82	1.25
West South Central.....	3.48	2.37	1.61
Mountain.....	45.03	24.39	11.81
Pacific.....	61.16	41.57	10.22
United States.....	17.65	9.76	4.46

COMMERCIAL AND MUNICIPAL CENTRAL STATIONS AND STREET AND ELECTRIC RAILWAYS.

Total electric power generated.—The aggregate in commercial and municipal central stations and electric railway stations amounted to 2,695,882 horsepower-years in 1912, or 71.4 per cent of all electric power generated in the United States during the

year. The largest amount was generated in New York, 517,244 horsepower-years, followed by California with 269,615 horsepower-years. By geographic divisions the Middle Atlantic, East North Central, and Pacific States lead with 823,413 horsepower-years, 612,458 horsepower-years, and 382,937 horsepower-years, respectively. In rate of increase from 1902 to 1912, the Pacific and Mountain States lead with 850 per cent and 487 per cent, respectively, or 3.2 and 1.8 times the average rate of increase for the United States. Electric power generated in the two groups combined increased 710 per cent or more than three times as rapidly as in the remainder of the United States, and three and a half times as rapidly as in the Eastern States.

The rate of increase by geographic divisions are given in the following table. Details for the several States may be found in Table No. 24 and on plate 41, Part II.

TABLE NO. 25.—Percentage of increase in electric power generated, commercial and municipal central stations and street and electric railways, by geographic divisions.

	1902-1912	1902-1907	1907-1912
New England.....	178	82	53
Middle Atlantic.....	179	91	46
East North Central.....	239	123	71
West North Central.....	218	106	54
South Atlantic.....	318	151	67
East South Central.....	267	130	69
West South Central.....	241	107	65
Mountain.....	487	167	129
Pacific.....	850	338	117
United States.....	269	123	66

ELECTRIC POWER GENERATED PER THOUSAND OF POPULATION.

The average for the United States in 1912 of electric power generated in central stations and electric railways per thousand of population was 28.23 horsepower-years, an increase from 18.61 horsepower-years in 1907 and 9.21 horsepower-years in 1902. Among the individual States Montana is first with 143.97 horsepower-years per thousand, or more than five times the average for the United States. California is second with 104.61 horsepower-years, or 3.7 times the average for the United States. By geographic divisions the Pacific and Mountain States lead with 83.45 horsepower-years and 52.78 horsepower-years, respectively. The two groups combined had an average of 71.70 horsepower-years, or nearly three times the average for the remainder of the United States, 24.55 horsepower-years, and 2.3 times the average for the Eastern States, 31.03 horsepower-years.

Amounts for the several geographic divisions appear in the following table. Details for the several States may be found in Table No. 26 and on plate 42, Part II.

FINANCIAL STATISTICS OF CENTRAL STATIONS.

This report considers the financial statistics of commercial central stations and municipal central stations only as data therefor are given in the reports of the Bureau of the Census for 1902, 1907, and 1912.

Costs of construction, equipment, and real estate, stock and bond issues, and funded debt are considered both in the aggregate, per thousand of population, and per horsepower of primary power, together with the total and percentage increases by census periods. Income, expenses, and surplus are considered in the

TABLE NO. 26.—Electric power generated per thousand of population, commercial and municipal central stations and street and electric railways, by geographic divisions, in horsepower-years.

	1912	1907	1902
New England.....	35.24	21.78	14.81
Middle Atlantic.....	40.80	30.96	17.51
East North Central.....	32.64	20.40	9.58
West North Central.....	15.54	10.70	5.49
South Atlantic.....	13.08	8.44	3.64
East South Central.....	8.48	5.60	2.57
West South Central.....	7.02	4.86	2.72
Mountain.....	52.78	28.98	13.64
Pacific.....	83.45	47.76	14.41
United States.....	28.23	18.61	9.21

Detailed figures for municipal central stations may be found in Tables 23 and 25 and on plates 36 and 37; for street and electric railways in Tables 23 and 25 and on plates 39 and 40; and for manufacturing plants in Tables 24 and 25 and on plates 43 and 44, all in Part II of this report.

RELATIVE POSITION OF THE WESTERN STATES IN AMOUNT OF ELECTRIC POWER GENERATED.

In the use of electric power as indicated by the amounts generated in central and electric railway stations and as estimated for manufacturing plants, the leading position of the Western States is even more pronounced than is their development of primary power. While primary power installed in the electrical industry increased 440 per cent in the 10 years 1902 to 1912, the amount of power generated increased 690 per cent, more than two and a half times as fast as in the remainder of the United States, and nearly three times as fast as in the three eastern groups. The power generated per capita in the Western States in 1912 for all purposes, including estimated amount in manufacturing plants, was more than twice as great as in the remainder of the United States. If estimated amounts generated and used in manufacturing plants are eliminated, the Western States show a per capita use of electric power nearly three times as great as in the remainder of the United States. The power generated by public utility corporations—commercial central stations—in the Western States in 1912 was nearly four times as great, per capita, as for similar stations in the remainder of the United States. In electric power generated by all stations, including manufactures, in power generated by central stations and electric railways, and in power generated by commercial central stations, the respective rates of increase in the Western States for the 10 years 1902 to 1912 were 690 per cent, 710 per cent, and 706 per cent, as compared with 270 per cent, 320 per cent, and 225 per cent for the remainder of the United States and 240 per cent, 277 per cent, and 200 per cent for the Eastern States.

aggregate, per thousand of population, per horsepower of primary power, and per horsepower-year of power generated. For the year 1912, income and expenses have been separated into classes and considered both in the aggregate and per horsepower-year of power generated.

As stated earlier in the report, commercial central station statistics for Oregon and Washington, in particular, and probably in less degree for several other States, are incorrect on account of the classification

of certain central stations which also operated street railways as central stations in 1907 and as railway stations in 1912. In particular the plants of the Portland Railway Light & Power Co. in Oregon and of the Puget Sound Traction, Light & Power Co. in Washington appear to have been so classified. Much the larger part of their business is central-station service and should have been so classified in 1912. The error is particularly apparent in the consideration of financial statistics. On this account the cost of construction, capitalization, and funded debt for commercial central stations show an actual decrease from 1907 to 1912 in the State of Washington, when without doubt there has been a very considerable increase. Totals for the Pacific group are also affected in large degree, and, to a less extent, the totals for the United States.

COST OF CONSTRUCTION, EQUIPMENT, AND REAL ESTATE.

The Bureau of the Census makes the following explanation concerning cost of construction, equipment, and real estate for the several census years:

The schedule used at the census of 1902 called for a separate statement as to the cost, during the year and to date, of land; buildings; overhead electric-service construction; underground electric-service construction; lamps, motors, meters, and transformers, wired for use; supplies of every description on hand; and miscellaneous equipment. The object of these inquiries was to ascertain the total cost of the plant and equipment, and the expenditures during the year for extensions, additions, and repairs. It was presumed that the electric companies kept an account of this kind, but a majority contended that it was impossible to report the cost in such detail, and many asserted that they had no data from which even the total cost of the plant and equipment to date could be estimated with a fair degree of accuracy. Moreover, a considerable number of the electric stations have changed ownership during recent years, and the purchase price often has little relation to the actual cost of the plant, and in fact seldom, if ever, represents this cost. The transfer is frequently made through the exchange of stock or by some other arrangement whereby it is impossible to ascertain the money equivalent. In view of these conditions, the attempt to ascertain the cost of construction in such detail was abandoned in 1907, but in an effort to preserve the comparative value of the statistics the total cost of the plant and equipment to date and the cost of construction during the census year were requested. Even this modification of the inquiry was unsatisfactory, and in 1912 it was still further simplified, and only the total cost of construction, equipment, and real estate was called for.

Many and varying factors enter into the cost of plants and equipment. Sites and rights, which in one instance may cost but little, in another may be very expensive. The equipment of a station designed and prepared to supply current to a large city or thickly settled community is quite unlike that of a station transmitting electricity considerable distances and selling in bulk to but few customers.¹

It is not probable that the amounts reported, at least by commercial central station companies, to the Bureau of the Census under the designations of "cost of construction, equipment, and real estate" represent actual cost in the sense of cash expenditures or their equivalent. Costs in this sense have rarely been kept except in recent years in a few of the States under the pressure of public-utility legislation requiring uniform systems of accounting. The public-utility commissions in the valuation of properties which have been in operation for any considerable period have found it practically impossible to secure accurate data of actual cost. In the second place, it appears to be the general practice of public-utility corporations to consider as "cost of construction, equipment, and real estate" the amount which will make assets equal to liabilities on their balance sheets. Regardless of actual expenditures this amount will vary from year to year according to the variations in the other items of

the balance sheet, and particularly according to the variation in outstanding stocks and bonds. In the majority of cases it would be more nearly correct to consider this item as "assumed present value of properties," rather than "investment in or cost of such properties." If from the total of outstanding common and preferred stock, funded and floating debt, cash investment and real estate mortgages of commercial central stations be deducted the duplications due to inter-company holdings and to securities held in treasury, the remainder, \$2,086,251,437, differs by only one-half of 1 per cent from the reported "cost." Apparently "cost," in general, means scarcely more than the net total of outstanding securities and investments.

COMMERCIAL CENTRAL STATIONS.

Total cost.—The total reported "cost" of commercial central stations in the United States up to 1912 was \$2,098,613,122, equivalent to \$21.97 per capita, and \$301 per horsepower of primary power installation. The increase from 1902 to 1912 amounted to \$1,615,893,243, or 335 per cent. By individual States, New York leads with a reported cost of \$348,696,341, followed by California with \$342,534,781. By geographic divisions the Middle Atlantic States are first, with a total of \$580,011,561, and the Pacific States second, with \$382,081,617.

Increase in total cost.—In amount of increase for the 10 years 1902 to 1912, California leads all other States with \$306,402,785, or an average annual increase of over \$30,000,000. Of this increase \$231,663,204 was in the five years 1907 to 1912, or more than \$43,000,000 a year. Only five other States increased as much for the entire period as California for each year of the period.

Fourteen States show a rate of increase for the 10 years in excess of 1,000 per cent. Two of these, Nevada and Idaho, show an increase of over 4,000 per cent. By geographic divisions the east South Central States are first, followed by the Pacific States and the Western States. These last two groups had an average increase of 761 per cent, or nearly three times (2.87) the average rate 265 per cent of increase for the remainder of the United States, and more than three and a half times (3.71) the average for the Eastern States.

Rates of increase in cost of construction of commercial central stations for the census periods are given in the following table. Details for the several States are given in Tables Nos. 27 and 28 and on plates 45, 46, and 47, Part II.

TABLE No. 27.—Percentage increase in reported cost of construction, etc., commercial central stations, by geographic divisions.

	1902-1912	1902-1907	1907-1912
New England.....	175	64	68
Middle Atlantic.....	178	86	49
East North Central.....	364	143	91
West North Central.....	336	120	98
South Atlantic.....	610	204	134
East South Central.....	778	205	187
West South Central.....	468	140	136
Mountain.....	756	141	255
Pacific.....	764	225	166
United States.....	335	118	99

Cost per capita.—In investment or cost per capita up to 1912 the Pacific States lead, with \$83.26, followed by the Mountain States with \$70.92. The average for the two groups is \$78.53 per capita, four and one-half times the average of \$17.19 for the remainder of the

¹ Central Electric Light and Power Stations, 1912, pp. 64, 65.

United States and nearly four times the average of \$21.63 for the Eastern States.

The reported cost per capita for the several geographic divisions are given in the following table. Details for the several States appear in Table No. 28 and on plate 48, Part II.

TABLE No. 28.—*Reported cost of construction per capita, etc., commercial central stations, by geographic divisions.*

	1912	1907	1902
New England.....	\$21.86	\$14.05	\$9.28
Middle Atlantic.....	28.71	21.31	12.84
East North Central.....	19.03	10.61	4.68
West North Central.....	13.38	7.14	3.45
South Atlantic.....	10.10	4.65	1.66
East South Central.....	8.23	3.02	1.04
West South Central.....	7.75	3.74	1.81
Mountain.....	70.92	24.06	12.57
Pacific.....	83.26	38.96	15.85
United States.....	21.97	12.05	6.08

Cost per horsepower.—The reported cost per horsepower for the United States was \$286 in 1902, falling to \$279 in 1907 and rising to \$301 in 1912. The highest horsepower costs appear in the Mountain and Pacific States, the former with \$485 and the latter with \$416. The lowest are in New England, with \$215. The magnitude of these figures is further evidence that they represent something more than actual "cost." Since they include both water power and steam power installation, it would be doubtful even in absence of other evidence if the real investment approaches such amounts.

Details of reported cost per horsepower for the several States and geographic divisions appear in Table No. 28 and on plate 49, Part II. Averages for the several geographic divisions are given in the following table:

TABLE No. 29.—*Reported cost of construction, etc., per horsepower, commercial central stations, by geographic divisions.*

	1912	1907	1902
New England.....	\$215	\$228	\$228
Middle Atlantic.....	293	356	378
East North Central.....	237	261	249
West North Central.....	309	246	288
South Atlantic.....	229	210	223
East South Central.....	393	278	174
West South Central.....	357	255	225
Mountain.....	485	257	225
Pacific.....	416	253	256
United States.....	301	279	286

MUNICIPAL CENTRAL STATIONS.

Total cost.—The total reported cost of municipal central stations up to 1912 was \$77,065,144, or 3.5 per cent of the amount reported for commercial stations, equivalent to \$0.81 per capita and to \$138 per horsepower of primary power installation. The increase from 1902 to 1912 amounted to \$55,044,671, or 250 per cent, as compared with 335 per cent for commercial stations. By individual States, Illinois leads with a reported cost of \$14,321,406. Washington, although having 13 per cent greater installation than Illinois, is second in total cost, with \$6,194,001. By geographic divisions the East North Central States lead, with \$31,473,659, or 41 per cent of the total for the United States.

Increase in total cost.—The Mountain States show the greatest rate of increase in total cost, or 1,840 per cent,

from 1902 to 1912. The Pacific States are second, with 762 per cent. These two groups combined show an average increase of 827 per cent, or nearly four times (3.72) the average rate of increase for the remainder of the United States.

Rates of increase by census periods for the several geographic divisions are given in the following table. Details of costs for the several States may be found in Table No. 29 and on plate 50, Part II.

TABLE No. 30.—*Percentage increase in reported cost of construction, etc., municipal central stations, by geographic divisions.*

	1902-1912	1902-1907	1907-1912
New England.....	208	142	27
Middle Atlantic.....	90	62	17
East North Central.....	196	60	84
West North Central.....	232	82	82
South Atlantic.....	357	161	75
East South Central.....	312	171	52
West South Central.....	620	167	170
Mountain.....	1,842	793	118
Pacific.....	763	220	169
United States.....	250	95	80

Cost per capita.—In amount expended per capita up to 1912 the Pacific States lead with \$1.88, followed by the East North Central States with \$1.68. The average for the United States is \$0.81 per capita. By individual States, Washington leads with \$4.83 per capita, six times the average for the United States, followed by Illinois with \$2.46 and Michigan with \$2.24 per capita.

Reported costs per capita for the several geographic divisions are given in the following table. Details for the several States may be found in Table No. 29 and on plate 51, Part II.

TABLE No. 31.—*Reported costs of construction, etc., per capita, municipal central stations, by geographic divisions.*

	1912	1907	1902
New England.....	\$0.82	\$0.69	\$0.31
Middle Atlantic.....	.20	.19	.13
East North Central.....	1.68	.97	.65
West North Central.....	.90	.52	.30
South Atlantic.....	.57	.35	.14
East South Central.....	.49	.34	.13
West South Central.....	.44	.18	.08
Mountain.....	.43	.24	.03
Pacific.....	1.88	.87	.36
United States.....	.81	.49	.28

Cost per horsepower.—The reported costs per horsepower of primary power installation in municipal central stations for the years 1912, 1907, and 1902 are \$138, \$133, and \$138, showing but slight variation during the 10 years. These costs are strikingly different from those reported for commercial stations, which were \$301, \$279, and \$286, respectively, or more than twice as great as for municipal stations. While municipal accounts may often omit items of expense which should properly be chargeable, and while for this reason costs per horsepower may be too low, the figures for municipal stations probably more nearly represent actual costs than the figures given for commercial stations.

COMMERCIAL AND MUNICIPAL CENTRAL STATIONS.

Total costs, increase in costs by periods, and costs per capita and per horsepower of primary power for commercial and municipal stations combined are not

far different from those for commercial central stations alone, on account of the small percentage which municipal stations figures are of the totals. The combined data, however, are given in Tables Nos. 30 and 31 and on plates 53, 54, 55, 56, and 57, Part II.

CAPITALIZATION AS REPRESENTED BY PAR VALUE OF STOCKS AND BONDS OUTSTANDING.

Stocks and bonds outstanding as reported to the Bureau of the Census appear to include not only securities in the hands of the public but also certain amounts held in the treasuries of the issuing companies. There is also a further duplication on account of the intercompany holdings of stocks and bonds of certain companies by other electric companies and which were reported both by the issuing company and by the holding company. The total duplication from these two sources amounted to \$126,305,618 in 1912, or about 6 per cent of the total reported. The figures as given in the tables in the report are the total issues as reported to the census and have not been corrected for duplication. The uncorrected figures, however, represent very closely the net capital employed, for as an offset to the deductions for duplications \$160,062,358 should be added for cash investments, real estate mortgages, and floating debt. With these added, the total of stocks and bonds outstanding for the United States as a whole differs from the total net capital by about 1½ per cent. If in addition deduction be made for investments not pertaining strictly to the electric industry, amounting in 1912 to \$76,721,716, there is left \$2,009,529,721 as the net capital engaged strictly in the electric industry. The total of stocks and bond issues as used in the report are therefore about 1½ per cent less than the aggregate net capital of all electric companies and about 2 per cent in excess of that part of the net capital employed strictly in the electric-power business.

The relation between capitalization as represented by the par value of stocks and bonds outstanding and the reported cost of construction varies largely for the three census years. In 1902 capitalization was 30 per cent in excess of reported cost and in 1907, 27.3 per cent in excess. In 1912 it was 2.2 per cent less. This changed relation from 1907 to 1912 may be due to more conservative practice in issuing securities or, in view of the considerable increase (\$22) in the reported cost per horsepower, to inflation in reported costs of construction, or to both.

The ratios of the par value of stocks and bonds outstanding to the reported cost of construction for the three census years, by geographic divisions, are given in the following table:

TABLE No. 32.—Ratio of par value of stocks and bonds outstanding to reported cost of construction, commercial central stations, by geographic divisions, in per cent.

	1912	1907	1902
New England.....	77	115	85
Middle Atlantic.....	94	115	157
East North Central.....	95	125	103
West North Central.....	105	156	102
South Atlantic.....	103	164	103
East South Central.....	97	110	112
West South Central.....	90	92	105
Mountain.....	102	121	150
Pacific.....	108	154	138
United States.....	98	127	130

In total of outstanding stocks and bonds in 1912, California leads with \$373,250,663, over 12 per cent in excess of the next State, New York, which had \$309,471,635. By geographic division, the Middle Atlantic States lead, with \$546,105,161, followed by the Pacific States, with \$413,985,341. In amount of increase from 1902 to 1912 California again leads, with \$322,192,618, or two and seven-tenths times as much as New York, which is the next State in order of increase. By geographic divisions, the Pacific States lead, with an increase of \$352,736,996, or nearly \$100,000,000 in excess of the next group, the East North Central States. The Pacific group would show a still larger increase had not certain central station companies, as previously explained, been classified by the Bureau of the Census as electric railway companies.

Stock and bond issues increased 114 per cent from 1902 to 1907, 53 per cent from 1907 to 1912, and 227 per cent from 1902 to 1912, as compared with corresponding increases of 118 per cent, 99 per cent, and 335 per cent in cost of construction. The highest rates of increase from 1902 to 1912 are found in the East South Central States, 661 per cent, and in the South Atlantic States, 613 per cent. The highest rate of increase for any individual State is found in North Dakota, 8,067 per cent. This, however, is due to the fact that North Dakota had practically no electric power developed in 1902, its stock and bond issues aggregating only \$91,000 in that year.

Stock and bond issues in the United States in 1912 amounted to \$21.49 per capita, as compared with \$21.97 per capita for cost of construction. Of the individual States, Montana led, with \$163.58 per capita, followed by California, with \$144.82 per capita. Capitalization per horsepower of primary power is highest in Idaho, or \$803, and lowest in Massachusetts, or \$118. Capitalization per horsepower for the United States has steadily reduced since 1902, when it was \$372, to \$355 in 1907 and \$295 in 1912.

No detailed data concerning dividends paid by commercial central station companies are presented by the Bureau of the Census. The report on central electric light and power stations for 1912, however, contains the following statement:

In 1912 the 2,663 commercial companies reported dividends on common stock to the amount of \$28,602,399, being equivalent to 2.9 per cent on \$977,639,057 of common stock, as compared with 2.5 per cent in 1907 and 1.6 per cent in 1902. The amount of dividends on the preferred stock in 1912 was \$5,978,473, equal to 3.4 per cent; in 1907 the rate was 3.2 per cent; and in 1902, 2.6 per cent. Some of the 2,663 companies reported for 1912 did not pay dividends for the census year, while others declared them upon one class of stock only.¹

The percentages given above are for dividends paid, not dividends earned. The latter are much greater. It is a common practice, particularly when the business of the electric company is expanding rapidly, to divert surplus earnings into extensions to property instead of into dividends, permitting stockholders to have a larger equity in the property in lieu of annual dividend payments.

Details of stock and bond issues for the several States, and amounts per capita, and per horsepower, may be found in Tables Nos. 32 and 33, and on plates 58, 59, 60, 61, and 62, Part II.

¹Central Electric Light and Power Stations and Street and Electric Railways, 1912, Bureau of the Census, p. 64.

FUNDED DEBT.

COMMERCIAL CENTRAL STATIONS.

The total funded debt of commercial central stations in 1912 amounted to \$897,907,681. The increase from 1902 to 1907 was \$346,113,762, or 136 per cent; from 1907 to 1912, \$297,229,996, or 49 per cent; and from 1902 to 1912, \$643,343,758, or 253 per cent. In 1912 California led with \$158,071,570, over \$7,000,000 in excess of the next State, New York. By geographic divisions, the Middle Atlantic States lead with \$266,347,898, followed by the Pacific States, with \$173,386,292. This last figure is too low, for reasons previously given.

In 1902 the funded debt of all commercial central stations in the United States was 53 per cent of the reported cost of construction for the year. In 1907 the percentage had risen to 57 per cent and in 1912 had fallen to 42 per cent. For these same years capitalization, as represented by the par value of stocks and bonds combined, was 130 per cent, 127 per cent, and 98 per cent, respectively. With funded debt, as with capitalization, the lower percentages in 1912 may represent either more conservative financing, or inflations in the reported costs of construction, or both. The highest ratio of funded debt to reported cost of construction for any of the geographic divisions is 80 per cent in the West North Central States in 1907. The lowest is 23 per cent in New England in 1912. Percentages for its several geographic divisions for these census years are given in the following table:

TABLE NO. 33.—Ratio of par value of funded debt to reported cost of construction, commercial central stations, by geographic divisions, in per cent.

	1912	1907	1902
New England.....	23	28	25
Middle Atlantic.....	46	59	72
East North Central.....	45	48	36
West North Central.....	52	80	40
South Atlantic.....	45	78	41
East South Central.....	39	50	54
West South Central.....	31	37	40
Mountain.....	37	44	53
Pacific.....	45	70	41
United States.....	43	57	53

Funded debt per capita in commercial central stations was \$9.40 in 1912, as compared with \$6.87 in 1907 and \$3.21 in 1902. The highest amount per capita is found in California, \$61.33. Montana is second, with \$53.52. By geographic divisions the Pacific States are first, with an average of \$37.78, followed by the Mountain States with \$25.99. Only one other group—the Middle Atlantic—with \$13.20, had a funded debt in commercial stations in excess of \$10 per capita.

The average funded debt per horsepower of primary power in commercial central stations in the United States in 1912 was \$129, a reduction from \$159 in 1907 and \$151 in 1902. The highest amount per horsepower is found in Idaho, with \$288; the lowest is Massachusetts, with \$12. By geographic divisions, the highest amount is in the Pacific States, with \$189 per horsepower, followed by the Mountain States with \$178 and the West North Central States with \$161.

Details concerning the funded debt of commercial central stations in the several States in the aggregate, in amount and rate of increase by periods, and in amount per capita and per horsepower, may be found in Tables Nos. 34 and 35, and in plates 63, 64, 65, 66, and 67, Part II.

MUNICIPAL CENTRAL STATIONS.

The funded debt of municipal central stations in the United States in 1912 was \$31,189,357, or a little less than 3.5 per cent of the funded debt of commercial stations. The increase for 1902 to 1907 was \$13,734,166, or 118 per cent; from 1907 to 1912, \$5,845,703, or 23 per cent; and from 1902 to 1912, \$19,579,869, or 169 per cent. The corresponding percentages of increase in commercial stations were 136 per cent, 49 per cent, and 253 per cent. Of the individual States in 1912, Washington was first, with \$3,683,200, followed by Ohio, with \$2,533,520, and Michigan, with \$2,496,601. By geographic divisions the East North Central States lead, with \$7,141,321. The West North Central are second and the Pacific States third.

In four States there was a decrease in funded debt of municipal stations during the five years 1902 to 1907. From 1907 to 1912 15 more States show a decrease. Also, in the later period, three of the geographic divisions—the New England, Middle Atlantic, and East South Central States—show a decrease in total bonded debt outstanding of 11 per cent, 8 per cent, and 18 per cent, respectively. One State—Rhode Island—retired the entire bonded debt of its municipal stations between 1907 and 1912.

In 1902 the funded debt of municipal stations in the United States was 53 per cent of the reported cost of construction, or exactly the same percentage that obtained for commercial stations. In 1907 the percentage had risen to 59 per cent, as compared with 57 per cent for commercial stations. In 1912 the percentage fell to 40 per cent, 3 per cent less than for commercial stations. When it is considered that the reported cost of construction in commercial stations is more than twice as great per horsepower as in municipal stations, the more conservative financing of municipal stations is apparent. The highest ratio of bonded debt to reported cost of construction in any geographic division is 97 per cent in the East South Central States in 1907; the least ratio is 23 per cent in the East North Central States in 1912. Percentages for the several geographic divisions for the census years are given in the following table:

TABLE NO. 34.—Ratio of par value of funded debt to reported cost of construction, municipal central stations, by geographic divisions, in per cent.

	1912	1907	1902
New England.....	52	74	60
Middle Atlantic.....	50	64	65
East North Central.....	23	42	46
West North Central.....	50	57	53
South Atlantic.....	55	75	63
East South Central.....	52	97	62
West South Central.....	55	72	41
Mountain.....	55	54	47
Pacific.....	55	70	55
United States.....	40	59	53

Funded debt per capita in municipal central stations in 1912, 1907, and 1902 was \$0.33, \$0.29, and \$0.15, respectively, as compared with \$9.40, \$6.87, and \$3.21 for the corresponding years in commercial stations. The highest amount per capita is found in 1912 in Washington, \$2.87. The only other State which was then \$1 per capita is Vermont, with \$1.51. On account of the comparatively large debt in Washington, the average for the Pacific States is \$1.04 per capita. The next largest group is the West North Central, with \$0.44 per capita.

The average funded debt per horsepower in municipal stations for the three census years was \$56 in 1912, \$79 in 1907, and \$73 in 1902. These figures may be compared with the corresponding figures for commercial stations of \$129, \$159, and \$151, which are more than twice as great. The highest amount per horsepower in 1912 was \$155 in Idaho, followed by \$129 in Oklahoma, and \$100 in South Carolina. These were the only States in 1912 with a funded debt in municipal stations of \$100 or more. The highest debt per horsepower in the several groups of States in 1912 was \$71 in the West South Central States. The Mountain and Pacific States were next with \$66 each. The least for any group is \$40 in the East North Central States.

Details concerning funded debt of the municipal central stations of the several States, in the aggregate, in amount and rate of increase by periods, and in amount per capita and per horsepower may be found in Tables 36 and 37 and on plates 68, 69, 70, 71, and 72, Part II.

INCOME, EXPENSES, AND SURPLUS.

The detailed schedules in accordance with which reports of income and expenses have been reported by the Bureau of the Census have varied considerably at the different census periods. For this reason comparisons between the data by States for the three periods can not readily be made. It would be necessary to prorate among the States certain items of expense which are given only for the United States as a whole. Among these items are interest upon funded debt, amounting to \$27,991,762, which was not classed as an item of expense in 1907, although so included in 1902 and 1912. Similarly, depreciation charges of \$18,843,863 and sinking-fund charges of \$1,654,035, a total of \$20,497,898, were included in the expenses of 1912. These items were not reported in 1902 or 1907, and therefore are omitted from the expenses as reported for those years. Tables Nos. 38 to 46, inclusive, and plates 73 to 96, inclusive, of Part II give income and expenses as reported for each census year. These tables and plates also show the difference between the income and expenses for each year as reported. On account, however, of the omissions above noted, 1912 is the only year in which gross expenses, as understood by modern accounting practice, are reported. The 1907 report gives operating expenses less depreciation and sinking-fund charges, and the 1902 report gross expenses less the same classes of charges.

The term "surplus" as used in this report is gross income less total expenses. The term "net income" is gross income less operating expenses, taxes, insurance, and depreciation charges. As thus used, except for the omission of depreciation and sinking-fund charges in 1907 and 1902, the tables and diagrams above named give gross income, total expenses, and surplus for 1912 and 1902, and gross income, total expenses, and net income for 1907.

In any analysis of income and expense accounts a clear distinction should be made between net income and surplus income, or, as the latter is often designated in public-service accounting systems, "corporate surplus," or simply "surplus." Net income is that portion of gross income remaining after the payment of operating expenses and depreciation charges, taxes, insurance, etc., and before the payment of interest or of sinking-fund charges. Net income divided by cost,

or investment, gives the average rate of return upon the investment; but may not and generally does not give the rate of return, or percentage of profit, enjoyed by the owners of the enterprise, the stockholders. Evidences of indebtedness carry a fixed rate of interest. Bondholders, as such, receive a specific rate of return. They do not share in the profits or, so long as the enterprise is solvent, sustain any of its losses. The profits of a business can be determined, therefore, only by the amount of the surplus¹—that part of the net income remaining after the interest charges have been paid. It is this amount which is available for the payment of dividends upon the stock. However, the surplus may not and generally is not devoted entirely to this purpose. A portion may be held in "reserves" as "floating capital" for the convenience of the business. A portion may be put into sinking funds for the retirement of bonded debt or into permanent capital in the form of extensions to plant. All three forms of disposition are for the benefit of the stockholders. The first facilitates the business; the second and third increase the stockholders' equity. For these reasons the amount of dividends *paid* may be little indication of the prosperity of an enterprise. The only real indication is the amount of dividends *earned*; that is, the "surplus."

In succeeding pages will be given data concerning expenses, gross and net income, and surplus of both commercial and municipal central stations for the census years 1912, 1907, and 1902. On account of the lack of a common basis of comparison for the several census years no discussion of the data for the years 1902 and 1907, or of the relation of these years to 1912, will be attempted. Attention will be directed only to the statistics of income, expenses, and surplus of commercial and municipal stations in 1912.

For purposes of comparison the data are given in the aggregate, per horsepower of primary power installed, and per horsepower-year of electric power generated. In order that there may be no misunderstanding of the data as thus reduced to amounts per unit of installation and per unit of output, attention is again called to the fundamental units employed in this report.

The term "horsepower" when applied to a machine is a unit of rate of work, not of *quantity* of work. The installed capacity in horsepower of a station represents, ordinarily, the maximum rate at which the station can operate. This does not change, regardless of whether the station is actually operating full time or is completely idle. Horsepower installation represents, therefore, ability to generate power, not power actually generated and made available for sale. The ratio between the average rate at which a station is operating during any given period of time and the installation, or maximum rate, of the plant is known as the "capacity load factor." It represents the ratio of actual utilization to complete and continuous utilization. This ratio for commercial and municipal central stations and street and electric railways for the three years 1912, 1907, and 1902 for the individual States and for the geographic divisions is given in Table 20, Part II.

¹ On account of the variations in the census schedules of expenses for the several census years, as explained on page 141, and on account of the form in which the census data are presented, the figures appearing in this report under designation of "Surplus" are net income less both interest and sinking-fund charges. Strictly speaking, the latter charges are a part of the surplus, since they are payment made for the purpose of reducing the capital debt and of increasing the stockholders' equity in the property. Actual surplus is therefore somewhat greater than is given in the report. If corrected for sinking-fund charges, the surplus for commercial central stations for 1912 would be \$62,914,750, instead of \$61,394,297—a difference of \$1,520,453, or 2.4 per cent.

In 1912 the average ratio for the United States was 26.2 per cent, with ratios of 35.4 per cent and 32 per cent in the Mountain and Pacific States, respectively.

The unit of power generated, a *quantity* unit, is the product of the *rate* unit multiplied by the *time* unit. It may be expressed in kilowatt hours, kilowatt years, horsepower hours, or horsepower years. The only difference between these four units is one of magnitude. The kilowatt hour is the unit most often employed and is the one in which prices or rates are most often expressed; but in order to show in this report the relation between machinery installed and its average rate of use, and the relation between income, expenses, and surplus per unit of installation and per unit of output, the "unit of rate of work" has been taken uniformly as the horsepower and the "unit of time" as the year. When so taken the average rate of power generation in horsepower and the total output in horsepower years for the unit of time are *numerically* identical.

In comparing income, expenses, and surplus on the basis of these two units, it should be remembered that what a power company sells is its *output*, not its *installation*. The latter is not a quantity and hence can not represent anything sold. Rates at which power is sold are based upon output, usually in kilowatt hours, and not upon installation in generating plants. Occasionally power is sold on what is known as a "flat-rate basis"; that is, at a certain amount per horsepower or per kilowatt of installation; not, however, of the installation of the generating plant but of the installation of the motors utilizing the power. The horsepower year as a unit of quantity of electrical energy is equal to 6,535 kilowatt hours. For purposes of comparison of the two units, it is convenient to remember that a rate of 1 cent per kilowatt hour is approximately equivalent to a rate of \$65 per horsepower-year.

Net income per unit of installation, when compared with cost of capitalization for the same unit, indicates the average return upon both contributed funds (stock) and borrowed funds (bonds). Surplus in the same unit indicates the return or profit or earned dividends upon the contributed funds. These are the relations in which the investor is chiefly interested. Net income and surplus per unit of output, on the other hand, when compared with gross income for the same unit, indicate what proportions of the rates paid by the public for the service rendered are retained by the public utility to pay interest upon debts and dividends upon stocks. These are the relations in which the consumer is interested.

In tables 47 to 52, inclusive, Part II, on which are shown an analysis of the income, expenses, and surplus of all central stations for the year 1912, quantities are shown only in the aggregate and reduced to the unit of output. Reductions to the unit of installation appear on tables 38 to 46, inclusive, Part II, on which tables will be found a comparison in parallel columns of income, expenses, and surplus for the year 1912, both per unit of installation and per unit of output.

COMMERCIAL CENTRAL STATIONS IN 1912.

Gross income.—The total gross income of commercial central stations in the United States in 1912 was \$278,896,610, of which 94.8 per cent was derived from electric service and 5.2 per cent for all other sources. The gross income amounted to \$40 per horsepower

of primary power installed, and to \$165 per horsepower-year of electric power generated. Of the \$165, \$156 was derived from electric service and \$9 from all other sources.

New York is first among the States in gross income, with \$56,618,990; California is second, with \$27,061,034. By geographic division the Middle Atlantic States lead with \$91,181,552, followed by the East North Central and the Pacific States. The figures for the latter group are too low for reasons previously given. The gross income for all stations is 13.3 per cent of the reported cost of construction and 13.6 per cent of the capitalization, as represented by the par value of outstanding stocks and bonds.

Gross income per horsepower-year of electric power generated averages \$165 for the United States. The highest receipts on this basis for any State are \$947 in Louisiana, followed by \$518 in Delaware, Maryland, and the District of Columbia. This latter figure is the average for the two States and the District since the statistics are not given separately in the reports of the Bureau of the Census. The least gross income was in Montana, with \$66 per horsepower-year. By geographic divisions, the Pacific and Mountain States are lowest, with \$107 and \$112 per horsepower-year, respectively, and the West South Central highest, with \$342. If income from strictly electric service is considered, Louisiana receives \$936 and Delaware, Maryland, and District of Columbia \$510 per horsepower-year. Montana is lowest, with \$56. The highest group is the West South Central, with \$334, and the two lowest are the Pacific and the Mountain groups, with \$102 and \$105 per horsepower-year, respectively.

Total expenses.—The total expenses of all stations for the year were \$217,502,313, or 78 per cent of the gross income. Of this amount 62.5 per cent was operating expense, 15.3 per cent taxes, insurance, and depreciation, and 22.2 per cent interest and sinking-fund charges. Total expenses amounted to \$31.21 per horsepower of primary power installed and to \$129 per horsepower-year of power generated. Total expenses were 10.4 per cent of the total reported cost of construction and 10.6 per cent of the total capitalization as represented by the par value of stocks and bonds outstanding. As in gross income, New York leads in total expense, with California second.

Average total expenses for the United States per horsepower-year of power generated are \$129, of which \$80 are operating expenses; \$20 taxes, insurance, and depreciation; and \$29 interest and sinking-fund charges. The highest expenses per horsepower-year are reported in Louisiana, \$658. The next is \$405 in Maryland and District of Columbia; the lowest is \$41 in Montana. By geographic divisions the Mountain and Pacific States are lowest, with \$87 and \$89 per horsepower-year, respectively.

Operating expenses per horsepower-year, with an average of \$80, are highest in Louisiana, with \$417; second in North Dakota, with \$253; lowest in Montana, with \$18. By groups of States the Mountain and Pacific States are still the lowest, with \$48 and \$50, respectively.

Taxes, insurance, and depreciation per horsepower-year, with an average of \$20, are highest in Louisiana and second in Maryland and District of Columbia. The lowest four States, North Carolina, South Carolina, Montana, and Nevada, have the minimum figure of \$4 each. The average for the Mountain group is \$8, and for the Pacific group \$12.

Interest and sinking-fund charges per horsepower-year, with an average of \$29, vary from \$139 in Louisiana and \$117 in Maryland and District of Columbia to \$11 in South Carolina. The lowest groups are the New England and East North Central, with \$24 each. The Pacific and Mountain groups, \$27 and \$31, respectively.

Net income.—This is taken as gross income, less operating expenses, taxes, insurance, and depreciation. The total net income for all stations in 1912 was \$109,779,513, or \$15.75 per horsepower of primary power and \$65 per horsepower-year of output. Total net income amounted to 5.23 per cent upon the reported cost of commercial stations and 5.35 per cent upon the total capitalization as represented by the par value of outstanding stocks and bonds. In net income New York leads with \$21,414,116, followed by California, with \$11,518,247. By geographic divisions the Middle Atlantic States lead with \$35,964,388, followed by the East North Central and the Pacific States in the order named.

Net income per horsepower-year of power generated, with an average of \$65 in 1912, varies from \$428 in Louisiana and \$243 in Delaware, to a minimum of \$35 in Kansas. By geographic divisions the Pacific and Mountain States were lowest with \$45 and \$56, respectively. The West South Central States were highest with \$132.

The ratio of net to gross income for all stations is 39.4 per cent. This ratio varies from a maximum of 67.5 per cent in Montana to a minimum of 26.5 per cent in New Mexico. The highest ratio by geographic divisions is found in the Mountain States, 50.6 per cent; the lowest in the East North Central States, 34.1 per cent. Ratios for the several States are given in Table No. 50, Part II.

Surplus.—This is taken as net income less interest and sinking-fund charges.¹ It represents the amount available for the payment of dividends. The total for the United States in 1912 was \$61,394,297, or 56 per cent of the net income for the year. This may be compared with the \$34,580,872 reported to the Bureau of the Census as having actually been paid in dividends on preferred and common stock in 1912.

The total par value of common and preferred stock of commercial central stations outstanding in 1912 was \$1,154,587,016. These figures contain duplications due to stocks held in the treasuries of the issuing companies and to intercompany holdings of stocks. Treasury stock amounted to \$16,418,819. Intercompany holdings of stocks are not reported separately from intercompany holdings of bonds, but the two together for the year 1912 amounted to \$77,787,160. Were this all bonds, the amount of stock entitled to participate in dividends would have been \$1,138,168,197, on which the surplus of \$61,394,297 would have been sufficient to pay dividends of 5.39 per cent. Were the entire intercompany holdings stock, the duplications would be \$94,205,979 and the net amount of outstanding stock \$1,060,381,037, upon which the above surplus would have been sufficient to pay dividends of 5.79 per cent. If it be assumed that the intercompany holdings were half stock and half bonds, the total duplications amounted to \$55,312,399, leaving \$1,099,274,617 entitled to participate in dividends, upon which the surplus would have been sufficient to pay a dividend of 5.58 per cent.

The amount actually earned presumably approximates this figure of 5.58 per cent, with 5.39 per cent and 5.79 per cent as extreme limits of variation established by assumptions manifestly improbable.¹ The dividends of \$34,580,872, reported to the Bureau of the Census as having actually been paid on both common and preferred stocks in 1912, amount to an average dividend rate of 3.04 per cent, 3.15 per cent, or 3.26 per cent, according to whether the intercompany holdings of securities be assumed as all bonds, half bonds and half stock, or all stock. These figures may be compared with the average interest rate of 4.52 per cent paid during the same period by commercial central stations as interest upon a floating and funded debt of \$1,035,634,066.

The total par value of common and preferred stock of the 11 Western States in 1912 was \$372,681,939. These figures, like those for the United States as a whole, contain duplications due to stocks held in the treasuries of the issuing companies and to intercompany holdings of stock. The amount of treasury stock was \$5,828,644. If the intercompany holdings of securities be assumed as all bonds, the amount of treasury stock is the only duplication and the remainder of \$366,853,295 represents the amount entitled to participate in dividends. Upon this the surplus of \$8,364,903 would have been sufficient to pay a dividend of 2.28 per cent. If the intercompany holdings of securities are assumed to be all stock, the total duplications are \$28,872,730, leaving \$343,809,209 entitled to participate in dividends, upon which the surplus would have been sufficient to pay a dividend of 2.43 per cent.

If it be assumed that the intercompany holdings of securities were half stock and half bonds, the total duplication amounts to \$17,350,687, leaving a balance of \$355,331,252 entitled to participate in dividends, upon which the surplus would have been sufficient to pay a dividend of 2.35 per cent. The amount actually earned will approximate this figure of 2.35 per cent, with 2.28 per cent and 2.43 per cent as the extreme limits of variation established, as before, by assumptions manifestly improbable.² These rates of dividends earned are less than one-half the figures for the United States as a whole. Whether these figures mean a less return upon the money actually invested or a considerable overcapitalization can not be determined; but it is at least interesting to note that the amount of capital stock outstanding in the Western States in 1912 was \$266³ per horsepower of primary power installation, as compared with \$158³ for the United States as a whole. The average rate of interest paid on a funded and floating debt of \$274,250,571 in the Western States during 1912 was 4.17 per cent, somewhat less than the average rate of interest for the United States as a whole.

Among the individual States, New York shows the highest surplus, \$12,779,122. Illinois is second with \$5,750,497, and California third with \$4,712,619, followed closely by Massachusetts with \$4,392,802. By geographic divisions, the Middle Atlantic States are first with \$20,382,097, followed by the East North Central, the New England, the West North Central, and the Pacific States, in the order named.

¹ If the surplus be taken as \$62,914,750, as explained in the footnote to p. 48, it would have been sufficient to pay dividends of 5.53 per cent, 5.72 per cent, and 5.93 per cent, according to whether the intercompany holdings of securities be assumed as all bonds, half bonds and half stock, or all stock.

² If to the surplus as above given be added the \$226,225 of sinking fund charges, as explained in the footnote to page 48, the total of \$8,591,128 would have been sufficient to pay dividends of 2.34 per cent, 2.42 per cent, or 2.50 per cent, according to whether the intercompany holdings of securities be assumed as all bonds, half bonds and half stocks, or all stock.

³ Assuming that intercompany holdings of securities are half bonds and half stock.

¹ See note, p. 48.

The average surplus for the United States per horsepower-year of power generated is \$36. The highest States are Louisiana, \$289; Delaware, \$150; Maryland and District of Columbia, \$113; and Iowa, \$107. No other State shows over \$100. The lowest are Idaho, \$3; Georgia, \$9; Kansas, \$15; and California and Michigan, \$18 each. By geographic divisions the Pacific States are lowest with \$18. The West South Central are highest with \$92.

Detailed figures for the several States may be found in Tables Nos. 49 and 50 and on plates 97 and 98, Part II.

MUNICIPAL CENTRAL STATIONS IN 1912.

Gross income.—Gross income for municipal central stations includes in addition to actual receipts the estimated value of free service, the total of which in 1912 equaled 20 per cent of the amount credited to electric service. The total gross income of all municipal central stations in the United States in 1912 was \$23,218,989, or 8.3 per cent of the gross income of commercial stations. Income from electric service afforded 97.6 per cent of the total gross income, amounting to \$42 per horsepower of primary power installed as compared with \$40 in commercial stations, and to \$281 per horsepower-year of electric power generated, as compared with \$165 for commercial stations. Of the \$281, \$274 was for electric service and \$7 from all other sources. In commercial stations the income from electric service was \$156; from all other sources, \$9.

Illinois leads in gross income with \$2,405,465. The States of Michigan, Ohio, Washington, Indiana, Massachusetts, and Minnesota, in the order named, have gross incomes of municipal stations in excess of \$1,000,000. By geographic divisions the East North Central States lead with \$7,654,814, one-third of the total for the United States. The gross income for all stations is 30 per cent of the reported cost of construction, as compared with 13.3 per cent for commercial stations.

Gross income per horsepower-year of power generated in municipal stations averages \$281 for the United States. The highest figure is \$821 in South Dakota, the lowest \$151 in Illinois. The average by geographic division is highest in the West North Central States, with \$423, the lowest in East North Central with \$201. The average income from electric service alone is \$274 per horsepower-year, varying from \$800 in South Dakota to \$150 in Illinois. The average income from all other sources is \$7 for the United States, varying from nothing in Rhode Island, Virginia, Wyoming, and New Mexico to \$40 per horsepower-year in Iowa. All of the West North Central States have a considerable income from sources other than electric service. The average for the groups is \$20 per horsepower-year or nearly three times the average for the United States.

Total expenses.—The total expenses of all stations for the year were \$16,917,165, or 72.8 per cent of gross income. Of this amount, 84.5 per cent was operating expenses; 6.2 per cent taxes, insurance, and depreciation; and 9.3 per cent interest and sinking-fund charges. The corresponding percentages for commercial stations were 62.5 per cent, 15.3 per cent, and 22.2 per cent. While some stations appear to have charged estimated taxes upon the municipal property engaged in electric service, the practice is not general, for no taxes are reported for 29 States. Total expenses were 22 per cent of the reported cost of construction. The highest total expenses for any State are in Illinois,

and for any of the geographic divisions, in the East North Central.

Average total expenses for the United States per horsepower-year of power generated are \$205, of which \$173 are operating expenses; \$13, taxes, insurance and depreciation; and \$19, interest and sinking-fund charges. The corresponding figures for commercial stations are: Total expenses, \$129; operating expenses, \$80; taxes, etc., \$20; and interest, etc., \$29. The highest expenses per horsepower-year are reported from South Dakota, \$630; and the lowest, from Illinois, \$105. Of the geographic divisions the East North Central States have the lowest average, \$144, and the West North Central the highest, \$329.

Operating expenses per horsepower-year averaged \$173 for all municipal stations as compared with \$80 for commercial stations, varying from a maximum of \$511 in South Dakota to a minimum of \$92 in Illinois, this minimum being higher than the average for commercial stations.

Taxes, insurance, and depreciation per horsepower-year average \$13 for municipal stations as compared with \$20 for commercial stations, varying from a maximum of \$75 in South Dakota to a minimum of \$1 in Oregon. The highest averages by geographic divisions are found in New England, \$29, and in the Pacific States, \$22.

Interest and sinking-fund charges per horsepower-year average \$19 for all municipal stations, as compared with \$29 for commercial stations, varying from a maximum of \$83 in Wyoming to a minimum of \$3 in Kentucky. By groups of States, the highest amount is found in the West South Central States, \$35, the lowest in the East North Central States.

Net income.—The total net income for all municipal stations in 1912 amounted to \$7,873,543, or 7.2 per cent of the net income of commercial stations. The net income of municipal stations for the year is 10.22 per cent of the reported cost of construction as compared with 5.23 per cent for commercial stations. The reported cost of commercial stations, however, is more than twice as much per horsepower as the reported cost of municipal stations. In net income Illinois leads with \$803,219, Washington is second with \$637,227. By geographic divisions the East North Central, West North Central, and South Atlantic States lead in the order named with more than \$1,000,000 for each group.

Net income per horsepower-year of power generated in municipal stations averages \$95, as compared with \$65 for commercial stations, varying from a maximum of \$304 in Idaho to a minimum of \$46 in Kentucky. By geographic divisions the Mountain States have the highest net income per horsepower-year, \$134, and the East North Central States the lowest, \$67.

The average ratio of net to gross income in municipal stations is 33.9 per cent as compared with 39.4 per cent for commercial stations. This ratio varies from a maximum of 56.3 per cent in Tennessee to a minimum of 20.9 per cent in Oklahoma.

Surplus.—The total surplus income of municipal stations in 1912 was \$6,301,824, or 80 per cent of the net income, as compared with 56 per cent for commercial stations. The high percentage of municipal stations is due to a lower funded debt, the debt per horsepower of primary power in 1912 being \$56 for municipal stations, as compared with \$129 for commercial stations.

Among the individual States Illinois shows the highest surplus, \$736,913, followed by Washington, with \$527,886. By geographic divisions the East North

Central States lead with \$2,180,518, more than a third of the total for the United States.

The average surplus for all stations per horsepower-year of power generated is \$76, as compared with \$36 for commercial stations, varying from a maximum of \$250 in Rhode Island to a minimum of \$18 in Oklahoma. By geographic divisions the South Atlantic States show the highest surplus, \$107 per horsepower-year, the East North Central States lowest, \$57 per horsepower-year.

Detailed figures for the several States may be found in Tables Nos. 51 and 52 and on plates 99 and 100, Part II.

Municipalities issue no stock in connection with their electric power enterprises. The Bureau of the Census uses the reported cost of construction as representing what would be the probable capitalization of such stations. Since the reported cost of commercial stations varies but slightly from their capitalization as represented by the par value of outstanding stocks and bonds, the assumption made with respect to municipal stations seems a reasonable one for purposes of comparison. The reported cost of municipal stations in 1912 was \$77,065,144. If from this figure be subtracted the funded debt of \$31,189,357, the balance of \$45,875,787 may be considered as the amount of stock which might be issued against the properties of all municipalities engaged in the electric power business if stock was issued against such properties. Upon this amount a surplus of \$6,301,824 for 1912 was sufficient to have paid a dividend of 13.75 per cent as compared with 5.58 per cent for commercial stations. This difference is mainly due to the higher reported cost of construction of the commercial stations. The average interest rate paid upon the funded and floating debt of municipal stations in 1912 was 3.98 per cent as compared with 4.52 per cent for commercial stations.

COMMERCIAL AND MUNICIPAL CENTRAL STATIONS.

On account of the small proportion of the total electric business done by municipal stations, the data for commercial and municipal stations combined are not materially different from those for commercial stations alone. The combined data, however, covering income, expenses, and surplus, have been computed and are given in Tables Nos. 47 and 48 and on plates 101 and 102, Part II.

COMPARATIVE FINANCES OF COMMERCIAL AND MUNICIPAL CENTRAL STATIONS.

The comparisons which have been drawn in the preceding pages between commercial and municipal stations show a considerable variation between the corresponding data for the two classes of stations. The total reported cost of municipal stations is 3.5 per cent of the reported cost of commercial stations. As far as "cost" may be taken as representing investment, commercial-station business is increasing at a more rapid rate than municipal. Since, however, costs of commercial stations are reported at more than twice the cost for municipal stations, it may be doubted whether municipal development is really proceeding at a less rate of increase than commercial-station development.

Since municipalities issued no stock on their plant, no comparison of capitalization can be made. The funded debt of municipal stations in 1912 bears approximately the same ratio to that of commercial sta-

tions as obtains in the reported cost of each. The funded debt per horsepower of primary power in commercial central stations in 1912 was more than twice the debt in municipal stations, being \$129 per horsepower for the former and \$56 for the latter.

The gross income of municipal central stations is 8.3 per cent of the income of commercial stations as compared with 3.5 per cent of reported cost of construction. Income from electric service was 97.6 per cent of the total for municipal stations, 94.8 per cent for commercial stations. Municipal income was \$42 per horsepower of primary power, as compared with \$40 for commercial stations, and \$281 per horsepower-year of power generated as compared with \$165 for commercial stations.

Total expenses of municipal stations are 73 per cent of the gross income; of commercial stations, 78 per cent. Of the municipal expenses, 84.5 per cent are chargeable to operation; of the commercial, 62.5 per cent. Taxes, insurance, and depreciation form 6.2 per cent and interest and sinking-fund charges 9.3 per cent of municipal expenses. The corresponding percentages for commercial stations are 15.3 per cent and 22.2 per cent. Total expenses of municipal stations amounted to \$205 per horsepower-year of power generated; of commercial stations, to \$129.

The net income of all municipal stations in 1912 was 7.2 per cent of the income of commercial stations, and amounted to 10.2 per cent upon the reported cost of construction as compared with 5.23 per cent for commercial stations. Such comparison, however, should take into account the fact that reported cost of commercial stations is more than twice that of municipal stations. Per horsepower-year of power generated, the net income of municipal stations was \$95; of commercial stations, \$65. The ratio of net income to gross income in municipal stations is 33.9 per cent; in commercial stations, 39.4 per cent.

The surplus for municipal stations in 1912 was 80 per cent of the net income; for commercial stations, 56 per cent; and amounted to \$76 per horsepower-year of power generated for the former and \$36 for the latter.

RELATIVE POSITION OF THE WESTERN STATES IN ELECTRIC POWER FINANCES.

The remarkable increase in power development in the Western States in recent years is still further evidenced by a consideration of the finances of commercial and municipal central stations, particularly the former. Although, in total reported cost of construction up to 1912, the Middle Atlantic States stand ahead of the Pacific States in actual increase for the period from 1902 to 1912, a Western State, California, with an increase of \$308,000,000, leads all other States by more than \$70,000,000. This one State had an average annual increase for 10 years of more than \$30,000,000 and for the 5 years, 1907 to 1912, of more than \$43,000,000. Only five other States increased as much for the five-year period as California for each year of the period.

The average rate of increase in plant investment, or "cost," of commercial stations in the Western States from 1902 to 1912 was nearly three times as great as for the remainder of the United States and more than three and one-half times the rate for the Eastern States. The investment, or "cost," per capita in the Western States is four and one-half times as great as in the remainder of the United States.

In the capitalization of commercial power companies, as represented by the par value of outstanding stocks and bonds, California leads all the other States by more than \$60,000,000, having from 1902 to 1912 increased its outstanding capitalization by \$373,000,000, or nearly three times as much as any other State. The increase in capitalization for the 10 years in the Pacific States is nearly \$100,000,000 in excess of that of any other group. Capitalization per capita and per horsepower of primary power was greater in the Western States in 1912 than in any other section of the country, amounting to \$464 per horsepower as compared with \$295 for the United States as a whole.

In funded debt as in capitalization of commercial stations, California leads all other States by more than \$7,000,000. The increase from 1902 to 1912 in the Western States was 704 per cent, more than three and one-half times the increase in the remainder of the United States (191 per cent). The funded debt per horsepower of primary power in the Western States is \$185 as compared with \$115 for the remainder of the United States. The higher reported cost, higher capitalization, and higher funded debt per primary horsepower in the Western States may be largely explained by the

greater proportion of water-power development at considerable distances from the markets supplied and the large investments required for the extensive transmission systems which are such a prominent feature of western power development.

In gross income from commercial central station operations in 1912 California was second only to New York. Average rates for power sold are less in the Western States than in any other section, as evidenced by an income from electric service per horsepower-year in 1912 of but 59 per cent of the similar income in the remainder of the United States. The average net income per horsepower-year in the Western States in 1912 was \$49 as compared with \$70 in the remainder of the United States, and an average of \$65 for the United States as a whole. The "surplus" from commercial central station operations in the Western States in 1912 was \$20.46 per horsepower-year, or less than half the amount, \$41.54, available in the remainder of the United States and but 56 per cent of the average, \$36, for the United States as a whole. The ratio of net to gross income is considerably greater in the Western States than in the remainder of the United States, being 45 per cent for the former and 38 per cent for the latter.

CONCENTRATION IN CONTROL OF ELECTRIC POWER.

There are several lines of evidence which show a continuously increasing tendency toward concentration in the control of the development, distribution, and sale of electric power. Each year shows a greater percentage of electric power being produced by commercial central stations—the public-service corporations. Each year also shows a few of the more prominent groups of interests securing control of a larger proportion of the central-station business. Some corporations, like the Utah Securities Corporation, the Montana Power Co., and the Pacific Gas & Electric Co., dominate a single compact territory; others, like Stone & Webster, H. M. Byllesby & Co., and the Doherty Operating Co., spread their operations widely, controlling smaller groups of operating companies in many distinct territories. Sometimes the character of the control is definite and distinct through actual ownership of properties or majority holdings of the stock or direct management of operating companies; sometimes it is indistinct and indefinite through representation on boards of directors. How great a degree of control is exercised in any particular case through mere representation on boards of directors is uncertain. It is scarcely to be supposed, however, that such representation is without influence even though the degree of influence may be problematical. Again, it will be found that many electric power corporations, particularly the holding companies, have representation through common directors in certain of the larger banking corporations. Whether this means the exercise of an influence by power corporations over the policies of the banking corporations, or vice versa, or how important such influence may be in any given instance, is indeterminate from any public sources of information. Suffice it to say that did such influence reach to the extent of control it would be of serious public concern. A control of the sources of credit would mean a control of the entire industry, would be the most effective means of stifling competition, and, regardless of how well the industry might be controlled in its service operations by public agencies,

would leave the opportunities of engaging in the business and the initiation of new enterprises in the hands of the few.

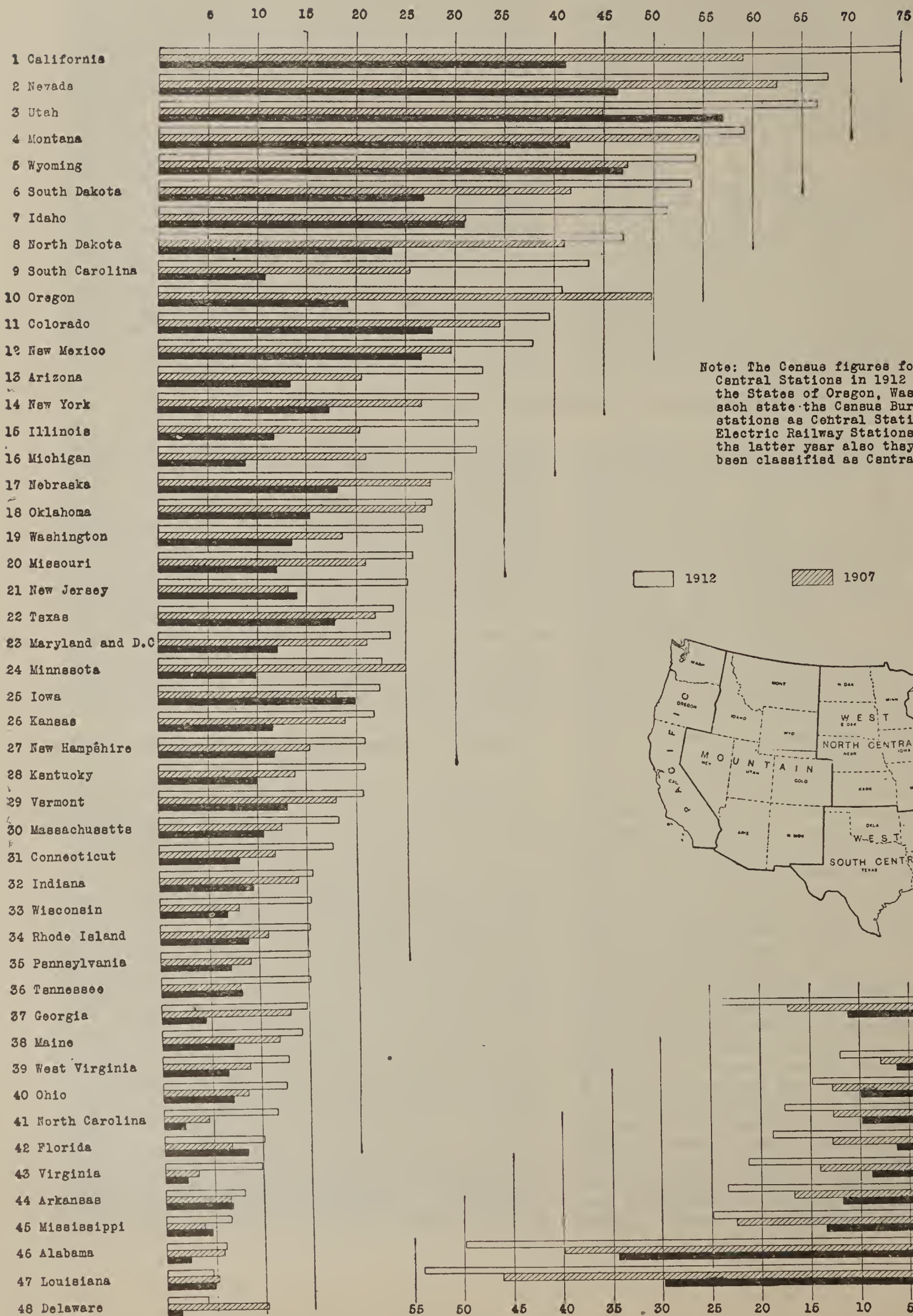
In the succeeding pages will be discussed the general concentration of the electric-power business into the hands of public-service corporations, the proportion of control which certain corporations exercise over the development of electric power in the several States, the extension of the operations of certain holding companies into several States and the steps by which they had secured control, the relation by common directors which exists between the several holding companies, and the relation through common directors of certain banking corporations to the electric-power holding companies.

INCREASE IN PROPORTION OF CENTRAL STATIONS POWER.

The tendency toward concentration of power development into the control of public utility corporations is clearly indicated by the statistics of primary power presented in the reports of the Bureau of the Census for 1902, 1907, and 1912, statistics which have been discussed in other connections in this report. Of all primary power—steam, water, and gas—employed in the electrical industry and in manufactures in 1902, 11.2 per cent was installed in commercial central stations. The proportion rose to 17.2 per cent in 1907 and to 23.8 per cent in 1912, more than doubling in the 10 years from 1902 to 1912. (See Plate X.) This movement toward concentration is found in all sections of the United States. The rate of increase in concentration was highest in the South Atlantic States, which had three times as great a proportion of primary power in commercial central stations in 1912 as in 1902. The extent of the concentration is greatest in the Western States. One-half of all primary power of all kinds in the Mountain States in 1912 was owned by public-service corporations and 54 per cent in the Pacific States. In California the proportion was three-fourths. To-day, only three years later, public-serv-

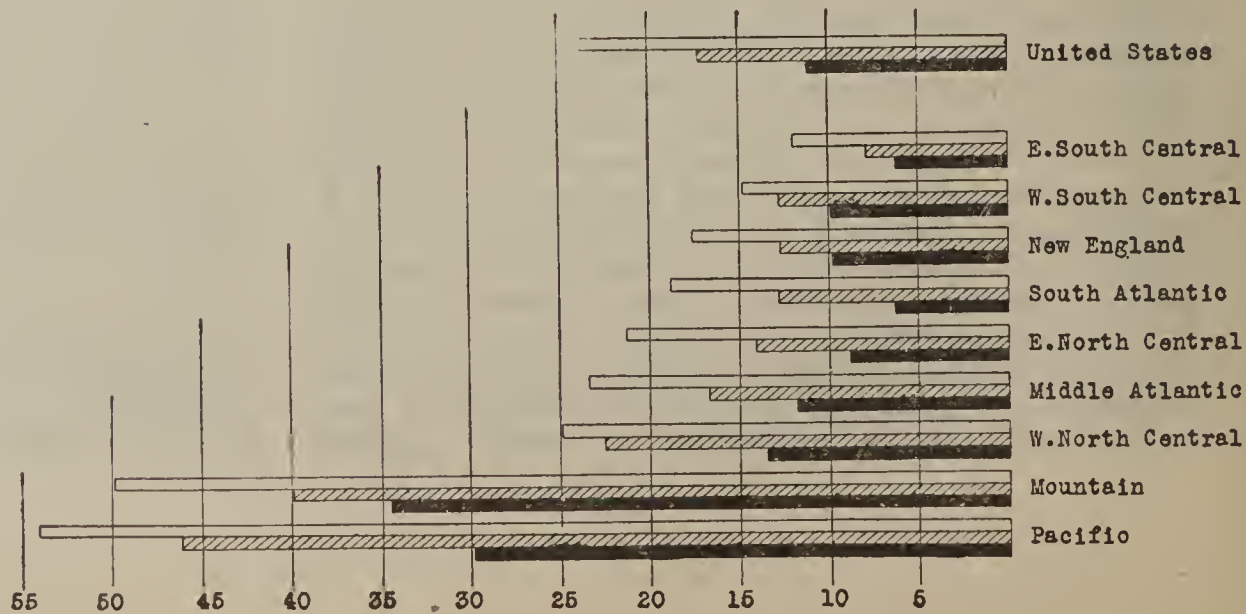
RATIO OF CENTRAL STATION PRIMARY POWER TO TOTAL PRIMARY POWER, 1912, 1907 AND 1902

PLATE 2

By States and by Geographic Divisions
In Per Cent of Total Power

Note: The Census figures for primary power in Central Stations in 1912 have been corrected for the States of Oregon, Washington, and Utah. In each state the Census Bureau classified certain stations as Central Stations in 1907 and as Electric Railway Stations in 1912, although in the latter year also they should properly have been classified as Central Stations.

1912 1907 1902



ice corporations own 90 per cent of all the primary power in those two groups of States. Although the 1915 data are not sufficiently complete in the other sections, particularly concerning power used in manufactures, to give definite percentages, it is probable that in the South Atlantic States the percentage of power controlled by public utility companies is well above 50 per cent, as compared with less than 20 per cent in 1912. Wherever marked activity in hydro-electric power development exists, as it has existed in recent years in the Western and Southern States, there especially is found in its highest degree the concentration of ownership by public-service corporations.

This particular tendency toward concentration need by no means be of ill omen. Monopolization of the supply in any given territory makes possible through interconnections of stations and through diversification of load, economies of operation that would not be possible for isolated independent stations. Interruptions to service may be lessened, the needs of the customer may be better served, and rates may be lower with a single power system than with several. No better service is given and no lower rates charged than in California where, notwithstanding the considerable municipal development, 90 per cent of the total primary power is owned by public-service corporations, or in Montana, where 89 per cent is owned by two affiliated corporations. Having the ability to give the better service and the lower rates, it only remains for the proper public agency to require it.

EXTENT OF CONTROL BY CERTAIN CORPORATIONS.

CONTROL BY OWNERSHIP OF STOCK OR PROPERTIES, OR BY LEASE OR MANAGEMENT.

From the detailed tabulations of companies, stations, and installations by States as given in Table No. 55, Part II, summary tables have been made showing the total water power, the total steam and gas power, and the total power of all kinds controlled by the principal corporations in each State, together with individual and cumulative percentages.

The names given are those of holding companies. The names of operating companies may be found on the detailed tabulations under the references as given on the summary table. In so far as the companies listed on the summary tables appear on the organization charts and the interconnecting directorates charts, they may be located by the reference lists which precede each set of charts.

In general, there have been included in the summary tables all corporations that own or control more than 1 per cent of the total power in a State. Only that degree of control which is represented by ownership of properties, majority stock ownership, management, or lease has been considered. In each table is also given the amount and the per cent of water power and of total power owned by municipalities, the total installation for the State in 1915 as appearing in the detailed tabulations, and the total installation in central stations and electric railways as reported by the Bureau of the Census for 1912. As on the detail tabulations the data, in general, include only commercial and municipal central stations and street and electric railways—the electrical industry. For the Western States, however, it is believed that the data are practically complete for all power. This is true as far as water powers are concerned in many of the other States, but

no attempt has been made to secure complete statistics of steam power in manufactures in the Central, Eastern, or Southern States. The chief purpose of this branch of the investigation has been to determine what proportion of the total power developed by municipalities and by public-service corporations is controlled by a limited number of such corporations. The percentages of control, therefore, as given in the tables and in the following résumés by States have reference, unless otherwise noted, to the proportions controlled by certain corporations and municipalities out of the total power developed by commercial and municipal central stations and by street and electric railways.

The summary tables for the several States appear in Table No. 54, Part II. Brief résumés follow for each State, showing to what extent the movement toward concentration has progressed.

Alabama.—One company, the Alabama Traction, Light & Power Co., has 87.9 per cent of the developed water power and 57.1 per cent of the total power of the State. Eight corporations control 90.1 per cent of the total power, and three of these 98.8 per cent of the water power. Thirty-four municipalities have but 0.8 per cent of the water power and 4.7 per cent of the total power.

Arizona.—Five companies control 47.4 per cent of the total power. Only one of these, the Arizona Power Co., has developed any water power. It has 26.8 per cent of the total for the State. The greater part of the developed water power is owned by the United States Reclamation Service, which, together with two municipalities, has 72.1 per cent of the water power and 27.6 per cent of the total power.

Arkansas.—Water power affords but little over 4 per cent of the total power. So far as data of developed water power could be secured, the total appears to be owned by two companies. Eleven companies control 73.5 per cent of the total power from all sources. The 17 municipal power stations have no water power and but 9.9 per cent of the total power in the State.

California.—Fifteen corporations control 88.6 per cent of the total primary power in the State, and 12 control 87.8 per cent of all the developed water power. Of these the largest is the Pacific Gas & Electric Co. with 20.1 per cent of the water power, or 152,080 horsepower, and 20.5 per cent of the total power, or 260,620 horsepower. Four corporations, the Pacific Gas & Electric Co., the Pacific Light & Power Corporation, the Southern California Edison Co., and the Western Power Co., together control more than half of both the water power and the total power in the State. Municipal developments comprise 6.3 per cent of the water power and 4.5 per cent of the total power.

Colorado.—Eight corporations control 73 per cent of the total power and five of these control 77 per cent of the water power. The largest is the Colorado Power Co. with 45.2 per cent of the water power and 24 per cent of the total power. This company, together with the Doherty Operating Co., the Utah Securities Corporation, and H. M. Byllesby & Co., control 68 per cent of the water power and 54.4 per cent of the total power. Ten municipalities own only 1.1 per cent of the water power and 1.9 per cent of the total power.

Connecticut.—Eight corporations control 92.7 per cent of the developed water power. Of these, one concern, Stone & Webster, controls 38.2 per cent. Four companies, the New York, New Haven & Hartford Railroad Co., the United Illuminating Co., The Hart-

ford Electric Light Co., and Stone & Webster control 53 per cent of the water power in the State. These four together with 11 others control 87.1 per cent of the total power. The six municipal plants have no water power and but 5.6 per cent of the total power.

Delaware.—The National Properties Co. controls 81.8 per cent of the total electric power installation for which data have been secured. Six municipalities have 8.5 per cent. Water-power development is negligible.

Florida.—Two concerns—Stone & Webster and the Florida Power Co.—control 99.6 per cent of the developed water power and 32.7 per cent of the total power. Eight companies control 58.6 per cent of the total power. Seventeen municipalities control 26.6 per cent of the total power, but have no water power.

Georgia.—Four companies—the Georgia Railway & Power Co., Stone & Webster, the Georgia Light, Power & Railways Co., and J. G. White & Co. (Inc.)—control 84.4 per cent of the developed water power and 73.8 per cent of the total power. Twelve companies control 88.1 per cent of the total power and 10 of these control 93.7 per cent of the water power. Seventy-five municipalities own but 0.7 per cent of the water power and 5.2 per cent of the total power. Of the total power for the State, as shown on the summary table, 5.8 per cent is used in manufacturing. On account of this inclusion, the percentages of control of strictly public-service power by certain corporations are greater than the above figures would indicate.

Idaho.—The Utah Securities Corporation controls 48.3 per cent of the developed water power and 45.5 per cent of the total power. This company, together with the National Securities Corporation, controls 70.8 per cent of the water power and 67.9 per cent of the total power in the State. The United States Reclamation Service and four municipalities control 9.4 per cent of the water power and 8.8 per cent of the total power.

Illinois.—Only 29.1 per cent of the developed water power is controlled by the major corporations. Of the total power, however, 89.2 per cent is controlled by 13 public-service corporations, one of which, the Commonwealth Edison Co., controls 55.6 per cent of the total developed power. Eighty-six municipalities, including the Chicago Sanitary District, have 63.4 per cent of the developed water power and 6 per cent of the total power.

Indiana.—This State has a relatively small water-power development. Of such development as has been made, 70.5 per cent is controlled by the Middle West Utilities Co. and the Indiana & Michigan Electric Co., the former with 54.4 per cent, the latter with 16.1 per cent. Thirteen corporations control 75 per cent of the total power, while 70 municipalities have but 2.5 per cent of the water power and 9 per cent of the total power.

Iowa.—Stone & Webster control 94.1 per cent of the total developed water power, equivalent to 47.4 per cent of the total power in the State. Thirteen corporations together control 80.7 per cent of the total power, and five of these 96.1 per cent of the water power. Seventy municipalities have 0.4 per cent of the water power and 5.3 per cent of the total power.

Kansas.—The Doherty Operating Co. controls 59.9 per cent of the developed water power. This company with two others controls 81.4 per cent of the water power. Seven concerns control 46.7 per cent of the total power in the State. Ninety municipal stations have 1.1 per cent of the water power and 24 per cent of the total power.

Kentucky.—As far as data are available there is no water-power development in this State by central stations or electric railways. Two companies, the Louisville Traction Co. and H. M. Byllesby & Co., control 60.6 per cent of the total developed steam power. Eleven companies control 84.7 per cent of the total power, and 18 municipalities 6 per cent.

Louisiana.—This State has no water-power development of consequence. One concern, the United Gas & Electric Corporation of Connecticut, controls 73.4 per cent of the total developed power from all sources. Six companies control 85.1 per cent. Twenty-five municipalities have 8.9 per cent of the total for the State.

Maine.—Over 58 per cent, chiefly water power, of the total power shown for the State of Maine is used in manufacturing. Of the total thus shown the largest percentages are controlled by the E. W. Clark Management Corporation, with 13.4 per cent of the water power and 16.4 per cent of the total power, and the International Paper Co. with 16.5 per cent of the water power and 15.9 per cent of the total power. Sixteen concerns control 91.1 per cent of the water power and 91 per cent of the total power. Five municipalities have only 0.7 per cent of the water power and 0.8 per cent of the total power.

Maryland and District of Columbia.—Water-power developments are of little importance, affording but 1.5 per cent of the total developed power. Nine companies control 94.9 per cent of the total power, and three of these, the United Railways & Electric Co. of Baltimore, the Consolidated Electric Light & Power Co. of Baltimore, and the Washington Railway & Electric Co., control 78.8 per cent of the total developed power. Seven municipal stations in Maryland have but 1.1 per cent of the total power developed in the State and District of Columbia combined.

Massachusetts.—Nineteen corporations control 83.5 per cent of the total power in the State, and eight of these control 77.8 per cent of the water power. Two companies, the New England Power Co. of Maine and the Turners Falls Power & Electric Co., control 56.2 per cent of the developed water power. Thirty-three municipal stations have 0.8 per cent of the water power and 4.2 per cent of the total power.

Michigan.—Eighteen corporations control 79.5 per cent of the total developed power and 15 of these control 76.2 per cent of the developed water power. Two concerns, the North American Co. and the Commonwealth Power, Railway & Light Co., control 53 per cent of the total power, and two, the Commonwealth Power, Railway & Light Co. and the Union Carbide Co., control 47.6 per cent of the water power. One hundred and four municipalities own 5.1 per cent of the developed water power and 8.8 per cent of the total power. Of the total power for the State as given in the summary tables, 4.2 per cent is used in manufacturing. Were it not for this inclusion, the percentage of control by certain companies of strictly public service power would be somewhat greater than the above figures indicate.

Minnesota.—Twelve companies control 89.9 per cent of the water power and 82.2 per cent of the total power. Four of these control 71.9 per cent of the water power and 65.4 per cent of the total power. One hundred and fifteen municipalities have only one-half of 1 per cent of the water power and 5.7 per cent of the total power.

Mississippi.—So far as data are available, Mississippi has no water power developed by public-service corpo-

rations. In the total power there is no marked concentration, the largest amount controlled by one concern, the Gulfport & Mississippi Coast Traction Co., being 14.1 per cent. Forty-two municipal stations have 25 per cent of the total power of the State.

Missouri.—Nine corporations control 86.3 per cent of the total power, and one, the Doherty Operating Co., controls 98.7 per cent of the water power. Three companies, the North American Co., the Doherty Operating Co., and the Kansas City Railway & Light Co., control 78 per cent of the total power in the State. Six per cent of the total is developed in municipal stations.

Montana.—Four corporations control 97.4 per cent of the water power and 91.8 per cent of the total power. Two of these, the Montana Power Co. and the Amalgamated Copper Co., affiliated concerns, control 94.4 per cent of the water power and 88.7 per cent of the total power. Municipal plants have no water power and but four-tenths of 1 per cent of the total power.

Nebraska.—Only 23.6 per cent of the developed water power is controlled by the major electric power corporations. The most important of these corporations are the Omaha Electric Light & Power Co. and the Omaha & Council Bluffs Street Railway Co. These two companies control 48 per cent of the public-service power in the State, but have no water power. The 73 municipal stations have 46.8 per cent of the developed water power and 19.7 per cent of the total power.

Nevada.—One concern, Stone & Webster, controls 73.6 per cent of the water power. This company, together with the Utah Copper Co., control 74.1 per cent of the total power in the State; 18.7 per cent of the water power is owned by the United States Reclamation Service. There are no municipal developments, although one town purchases and distributes power.

New Hampshire.—Three manufacturing concerns—the Berlin Mills Co., the Amoskeag Manufacturing Co., and the International Paper Co.—have 64 per cent of the developed water power and 48 per cent of the total power. Fourteen companies, both manufacturing and public service, control 88.1 per cent of the water power and 85.9 per cent of the total power. Two municipalities have 0.6 per cent of the water power and 0.8 per cent of the total power.

New Jersey.—Less than 3 per cent of the total power in the State is water power. Of this amount 87.5 per cent is controlled by two companies, the New Jersey General Security Co. and W. S. Barstow & Co. Of the total power 68.6 per cent is controlled by one concern, the Public Service Corporation of New Jersey. Nine other concerns together control 17.2 per cent of the total power. Ten municipalities have 1.1 per cent of the water power and 0.9 per cent of the total power.

New Mexico.—Water power affords less than 4 per cent of the total developed power. Of the total power the Federal Light & Traction Co. controls 37.1 per cent. Eight companies together have 66.9 per cent of the total. The United States Reclamation Service and certain municipalities, with four stations, have 22.9 per cent of the total developed power.

New York.—Twenty corporations control 81.4 per cent of the total developed power, and 14 of these control 74.3 per cent of the developed water power. Five companies control over one-half of the total power and two over one-third of the water power. Forty-eight municipalities have 0.4 per cent of the water power and 0.6 per cent of the total power. Of the totals for

the State as appearing on the summary table, nearly 12 per cent is power used in manufacturing. If this were omitted from the totals, the percentage of total public-service power controlled by the five largest corporations would be nearly 60 per cent, and of public-service water power by the two largest water-power companies 45 per cent.

North Carolina.—Two companies—the Southern Power Co. and the Carolina Power & Light Co.—control 75.1 per cent of the developed water power and 66.5 per cent of the total power. Eight corporations control 94 per cent of the water power and 14, 89.1 per cent of the total power. Forty-nine municipalities have 1 per cent of the water power and 5.5 per cent of the total power. Since the totals for the State contain a certain amount of power used in manufactures, the percentages of strictly public-service power controlled by the several corporations is greater than the above figures would indicate.

North Dakota.—Water-power development in this State is negligible. One concern, H. M. Byllesby & Co., controls 36.7 per cent of the total electric power in three stations, as compared with 22.3 per cent controlled by the United States Reclamation Service and certain municipalities in 12 stations.

Ohio.—Ohio shows no marked concentration of electric-power development, although 20 concerns control 77.8 per cent of the total in the State, and 7 of these have 67.1 per cent of the total developed water power.

One hundred and fourteen municipalities own 0.9 per cent of the water power and 7.5 per cent of the total power.

Oklahoma.—Nine companies control 61.9 per cent of the total power. Water-power development in the State amounts to but little over 2 per cent of the total. Sixty-one municipalities have 20.4 per cent of the water power and 16.7 per cent of the total power.

Oregon.—E. W. Clark & Co. Management Corporation and the Crown-Willamette Paper Co. control 67.7 per cent of the water power and 65.7 of the total power in the State. Seven companies control 86.4 per cent of the water power and 82.5 per cent of the total power. Municipal plants control 3 per cent of the water power and 2.2 per cent of the total power.

Pennsylvania.—Fifteen corporations control 73 per cent of the total public-service power in the State, and six of these control 88.2 per cent of the water power. One concern, the Pennsylvania Water & Power Co., controls 70 per cent of the developed water power. Forty-one municipalities have 0.3 per cent of the water power and 1.6 per cent of the total power of the State.

Rhode Island.—As far as information is available, Stone & Webster control the entire amount of developed water power used in public-service operations. Four companies, the New York, New Haven & Hartford Railroad Co., the Narragansett Electric Lighting Co., the Massachusetts Lighting Cos., and Stone & Webster, control 98.3 per cent of the total public-service power in the State. There appear to be no municipal developments.

South Carolina.—One concern, the Southern Power Co., controls 56.3 per cent of the developed water power and 50 per cent of the total power. Twelve companies control 96.4 per cent of the water power and thirteen 92.3 per cent of the total power. The 21 municipal plants have no water power and but 1.7 per cent of the total power. As noted in the summary table for the

State, 9.6 per cent of the power included in the totals is used in manufacturing. The percentage of strictly public-service power controlled by the several corporations listed is therefore greater than the above percentages would indicate.

South Dakota.—The Homestake Mining Co. has 47.8 per cent of the total water power in the State. Three other companies control 43.1 per cent, making a total of 90.9 per cent for the four. The 17 municipal stations have no water power and but 5 per cent of the total power.

Tennessee.—Two corporations, the E. W. Clark Co. Management Corporation and the Chattanooga & Tennessee River Power Co., control 88.9 per cent of the developed water power and 62.5 per cent of the total power. Five companies control 98.3 per cent of the water power and nine companies 92.9 per cent of the total power. Twenty-nine municipal plants contain but one-third of 1 per cent of the water power and but 3.7 per cent of the total power.

Texas.—Three companies control 68.5 per cent of the water power, and two companies, Stone & Webster and the American Power & Light Co., control 53 per cent of the total power. Thirteen companies control 77 per cent of the total power. Twenty-one municipalities have 3.3 per cent of the water power and 3.8 per cent of the total power.

Utah.—One concern, the Utah Securities Corporation, controls 82.2 per cent of the developed water power and 84.3 per cent of the total power. Twenty-two municipalities have 7.4 per cent of the water power and 6 per cent of the total power.

Vermont.—Two public-service companies, the New England Power Co. of Maine and the American Gas Co., and one manufacturing concern, the International Paper Co., control 51.6 per cent of the total developed water power and 44.4 per cent of the total power. Fifteen companies control 90.7 per cent of the water power and 89.2 per cent of the total power. Thirteen municipalities have 4.2 per cent of the water power and 4.6 per cent of the total power. As noted for several other States, power used in manufacturing to the extent of 20 per cent of the total has been included. Were it not for this inclusion the percentages of control of public-service power by certain corporations would be considerably greater than would be indicated by the above percentages or those shown in the summary table for the State.

Virginia.—Two public-service corporations, the Virginia Railway & Power Co. and H. M. Byllesby & Co., and one manufacturing concern, the Riverside & Dan River Cotton Mills, control 56.4 per cent of the developed water power and 56.9 per cent of the total power. Fourteen companies control 85.3 per cent of the total power, and nine of these control 80.5 per cent of the water power. Fifteen municipal stations control 6.5 per cent of the water power and 6 per cent of the total power.

Washington.—Two concerns, Stone & Webster and the Washington Water Power Co., control 53.8 per cent of the water power and 54.7 per cent of the total power. Ten corporations control 78.6 per cent of the water power, and 12 control 77.5 per cent of the total power. Washington has a considerable municipal development, 12 cities and towns owning 16.5 per cent of the water power and 16 per cent of the total power in the State.

West Virginia.—Five companies control 97.3 per cent of the developed water power and one concern,

the Union Carbide Co., 49.4 per cent. Fifteen companies control 85.1 per cent of the total power. Six municipalities have 1.3 per cent of the total power, but no water power.

Wisconsin.—74.6 per cent of the developed water power is distributed among 18 corporations. The largest percentages in control of single corporations are 11.5 per cent by H. M. Byllesby & Co. and 10.7 per cent by the Wisconsin River Power Co. Similarly 71.2 per cent of the total developed power of the State is distributed among 19 corporations, the North American Co. having the largest individual percentage of 25.5 per cent. Eighty-five municipalities have 1.4 per cent of the water power and 4.1 per cent of the total power. The totals for this State contain a considerable amount—19 per cent of the total—of power used in manufacture, hence the percentages of strictly public-service power controlled by the several companies is greater than the above percentage would indicate.

Wyoming.—Water-power development is of minor importance in Wyoming, the total amounting to only 2,544 horsepower. The total electric power installation from all sources is less than 18,000 horsepower. Two corporations control 44.2 per cent of this, and nine 77.7 per cent. The United States Army and municipal stations utilize 34 per cent of the water power and 7.1 per cent of the total power.

United States.—At the end of the summary tables is given a list of the 87 corporations each of which, according to the data given in the detailed sheets, controls not less than 30,000 horsepower of primary power. Two companies contained in the list, the International Paper Co. and the Union Carbide Co., are engaged in manufacturing. The remaining 85 are public-service corporations. These 87 corporations control 3,521,423 water horsepower and 6,275,092 steam and gas horsepower, a total of 9,796,515 horsepower, or 65.9 per cent of the total listed for the United States. If the two manufacturing concerns are eliminated and the amount of manufacturing power contained in the tables is subtracted from the total, the 85 concerns remaining control 68.6 per cent of the total public-service power in the United States. Thirty-five of the 85 control one-half of this total; 16 control one-third and 10 control one-fourth. Of the 85 corporations shown in the table 59 have water-power developments and control 65.9 per cent of the total water power listed. If the two manufacturing concerns are eliminated from this number and the water power used in manufacturing is subtracted from the total water power, the remaining 57 concerns control 72.3 per cent of the total water power in the United States used in public-service operations. Of these 57 concerns the following 18—

1. Stone & Webster.
2. Montana Power Co.
3. Utah Securities Corporation.
4. E. W. Clark & Co. Management Corporation.
5. Southern Power Co.
6. Hydraulic Co. of Niagara Falls.
7. Pacific Gas & Electric Co.
8. Pennsylvania Water & Power Co.
9. Pacific Light & Power Corporation.
10. H. M. Byllesby & Co.
11. The Niagara Falls Power Co.
12. Washington Water Power Co.
13. Georgia Railway Light & Power Co.
14. New England Power Co. of Maine.
15. Western Power Co.
16. Alabama Traction, Light & Power Co.
17. Commonwealth Power, Railway & Light Co.
18. United Railways Investment Co.

together control 2,356,521 water horsepower, more than one-half (51.1 per cent) of the total water power used in public-service operations in the United States. Of the 18 corporations named, the first 9 control more than one-third (33.7 per cent) of the total, and the first 6 more than one-fourth (25.3 per cent).

Stone & Webster, through their management of operating companies, control more water power and more total power than any other corporation, having under their direct management 340,211 water horsepower and 529,854 total horsepower.

Twenty-nine of the 87 companies listed control operating plants in more than one State. Three of these, H. M. Byllesby & Co., the Doherty Operating Co., and Stone & Webster, operate in 17, 14, and 13 States respectively. The Middle West Utilities Co. has the largest number of stations under its control—118 in 9 different States.

Attention is again called to the fact that the character of control which has been discussed with reference to the several States is definite and complete. It consists either in actual ownership of properties, in majority stock ownership, in lease or in direct management. The relation between the various operating companies and the controlling or holding companies is best shown upon the organization charts, presented in Part II of this report. The figures of amounts of power controlled as given upon these charts do not agree in all respects with the data given in the preceding pages. The detailed figures for the several States had not been completed when the organization charts were prepared and it was necessary to secure such information as could be obtained from corporation manuals without the opportunity of checking the information so secured against detailed data. Wherever discrepancies are found, the data contained in the preceding pages should be given preference.

INTERRELATIONSHIPS THROUGH COMMON DIRECTORS.

A study of the interrelation of the various public-utility electric corporations with each other through common directors or principal officers leads one into an almost endless maze of interconnections. It is extremely difficult to correlate the mass of information and to determine in many instances whether a particular company has the closer association with one or another group of interests. In studying the extent of such interrelationships the chief source of information has been Moody's Manual of Corporations, 1914. The 1915 edition was not available at a sufficiently early date to permit of its use in this line of investigation. The relations shown, therefore, unless otherwise noted, are those existing in 1914. It has not been possible, of course, even had it been desirable, to verify the data as presented in the several corporation manuals. The standing which they have and the presumption that all the information which they contain has been furnished by the corporations the activities of which are described would seem to make further verification unnecessary. The accuracy of the data herein presented is dependent, therefore, upon the accuracy of the sources from which they have been derived.

In Table No. 1, Part III, is given in alphabetical order a list of some 1,500 corporations engaged in the power business under each of which is listed, also in alphabetical order, both the power corporations and the banking corporations with which it is affiliated through principal officers or common directors. The list gives also

the total number of principal officers and directors in each corporation and the number common to such corporations and every other affiliated corporation. The principal officers considered are the president, vice president, secretary, and treasurer, but such officers have not been counted a second time if they serve also as directors. There is also given in Table No. 2, Part III, a list in alphabetical order of 2,172 directors and principal officers common to two or more of the corporations studied, and under each director or principal officer a list both of the power corporations and of the banking corporations in which he serves. These two lists serve as the fundamental data for this section of the report.

In contradistinction to the corporate relationships discussed in preceding pages of this report, where only ownership, lease, and management were considered, and where the connection was definite and direct, the interrelationships which are evidenced by common directors are indefinite and the extent of control can not be quantitatively determined, except in those instances where a majority of the directorate is common to two corporations. Where the preceding data show accomplished control, these data show potential control, a marked tendency toward an association or community of interest, particularly between the principal holding companies, that can not be viewed without concern.

From the general data just described have been prepared three charts, Nos. 1, 2, and 3, of Part III. The first chart shows the interrelations, through common directors or principal officers, that exist between 195 of the principal electric power holding companies. The second chart shows the relationship, through common directors, between 158 of the electric power holding corporations, shown on chart 1, and 147 of the banking corporations, shown on chart 3. The third chart shows the interrelation, through common directors, of 174 banking corporations of New York, Boston, Philadelphia, and other cities, including all except 16 of those appearing on plate 2.

Each of the companies shown upon the first chart is either directly or indirectly connected with every other company shown thereon. From this chart have been prepared the diagrams, 16 in number, which show graphically the relations between certain selected holding companies and other holding companies with which the first appears to have the closest relation. There is a certain amount of duplication of companies between these diagrams, since it has often been found desirable to show the relation which exists between a minor holding company and more than one of the major holding companies. Such duplications of this nature as exist have been indicated in the reference table preceding the diagram.

Each of the 16 diagrams is preceded by a prefacing sheet explaining the relations shown upon the diagram. To these sheets and the diagrams themselves, as well as to the general statement preceding all the diagrams, reference should be made for detailed information. Upon the several prefacing sheets is given a table showing the authorized and outstanding stock and the outstanding bonds of the individual concerns listed, and the amount of developed water power, steam and gas power (all shown under "Steam power"), and total power controlled.

The capitalization appearing opposite the names of the individual companies is the amount authorized or outstanding of the parent company and does not include the capitalization of any of the subsidiaries which

it may control. Even as thus taken there is doubtless a considerable, although unknown, duplication due to inter-company holdings of securities. In combining the individual companies into the groups appearing on the several charts there may be a still further duplication of capitalization due to the fact that two or more individual companies listed in a table may be so related through stock ownership that the capitalization of one is a duplication in whole or in part of the capitalization of another. Since it is not possible to determine the amount of duplicated capital either in the individual totals or in the group totals, such group totals are merely the numerical sums of the items appearing in the several tables and can not be taken as representing the net capitalization of the companies appearing in the table and upon the accompanying diagram.

The figures for developed power are taken from the detailed power data by States as given in Part II and are for the year 1915. As stated elsewhere in this report the totals which are here given for any individual company or combination of companies may differ from the totals appearing upon the organization charts in Part III. It was necessary to prepare the tables for the organization charts before the detailed power census for 1915 had been completed, and such information was used as could be secured from the corporation manuals. The information thus obtained was incomplete and in some instances incorrect. In case of conflict, therefore, the data shown upon the prefacing sheets to the interconnecting directorates charts should be given preference over that appearing upon the organization charts. Differences may also appear between the totals shown in connection with these charts and the totals appearing upon the tables in Part II which give the amount of power controlled by certain corporations. This is due to the fact that in the charts of Part III subsidiary concerns are shown as well as the main holding companies, and the power under the control of the main holding company does not always contain the power controlled by its subsidiaries if such subsidiaries appear independently in the tables.

There are no duplications in the data of developed power within any of the individual companies appearing upon the interconnecting directorates diagrams. Such duplications as exist between the several companies within any one group are shown upon the prefacing sheet accompanying the chart, and the total there given, less the duplications shown, gives the actual amount under the combined control of the several companies appearing upon the chart.

The character of the control over such developed power by the individual companies included in the several groups is direct and complete and is exercised either through ownership of the properties, majority ownership of stock, lease, or direct management. What may be the character of the group control, or whether such control actually exists, can not be determined. The only evidence available shows merely an interrelation between certain interests through common officers or through the medium of common representation upon boards of directors. It is scarcely to be supposed, however, that such representation is devoid of significance and that no influence exists because its amount can not be quantitatively determined.

The individual public-service companies which make up the 16 groups control 2,226,000 water horsepower,

or 48.3 per cent of total public-service water power in the United States, as indicated by the special census made for this report. These companies also control 4,160,000 steam horsepower, or 44.5 per cent of the total used in public service operations, giving a combined total of 6,386,000 horsepower, or 45 per cent of all public-service power in the United States.

The companies which appear at the left of each chart and which are given below are the companies, the interrelations of which with other companies have been studied, and with which the others as shown upon the several charts appear to be most closely related. As a means of distinguishing the several groups the names of the principal companies have been applied to the groups in which they appear.

A brief résumé of the total amounts of power controlled by the individual companies within the several groups follows. Details may be found upon the charts and in the prefacing sheets immediately preceding.

W. S. Barstow & Co.—Plate 4 shows the interrelations through common directors or principal officers of W. S. Barstow & Co., the General Gas & Electric Co., and six other public-service corporations. The individual companies appearing in this group control 34,775 water horsepower and 121,862 steam horsepower, a total of 156,637 horsepower, slightly more than 1 per cent of the total public-service power in the United States in 1915.

William P. Bonbright & Co.—Plate 5 shows the connections between Wm. P. Bonbright & Co. and 33 other companies. The individual companies shown in this group together control 885,725 water horsepower, or 19.2 per cent of the total used in public-service operations in the United States; and 655,613 steam horsepower, or 7 per cent of the total of such power in public-service use; making an aggregate of 1,541,338 horsepower, or 11 per cent of the total in the United States in 1915.

H. M. Byllesby & Co.—Plate 6 shows the connection through common directors or principal officers of H. M. Byllesby & Co., the Northern States Power Co., the Standard Gas & Electric Co., the Louisville Gas & Electric Co., and the Mississippi Valley Gas & Electric Co. with each other and with 16 other public-service corporations. The aggregate amount of power controlled by the individual companies shown within this group is 345,692 water horsepower and 469,386 steam horsepower, a total of 815,078 horsepower, or 7.5 per cent, 5 per cent, and 5.8 per cent, respectively, of the water power, steam power, and total power in the United States employed in public-service operations.

E. W. Clark & Co. Management Corporation.—Plate 7 shows the relations through common directors or principal officers of E. W. Clark & Co. Management Corporation, the Tennessee Railway, Light & Power Co., Commonwealth Power, Railway & Light Co., Cumberland County Power & Light Co., and the East St. Louis & Suburban Co. to 38 other corporations. With the exception of the International Paper Co., all the companies included in this group are public-service corporations. If the amount of power controlled by the International Paper Co. is subtracted from the aggregate amount controlled by all the individual corporations shown, the remainder amounts to 843,049 water horsepower and 1,266,183 steam horsepower, a total of 2,109,232 horsepower, or 18.3 per cent, 13.5 per cent, and 15.1 per cent, respectively, of the total

water power, steam power, and combined power in the United States operated by public-service corporations.

Doherty organizations.—Plate 8 shows the connections of the Electric Bond Deposit Co., the Doherty Operating Co., the Doherty Securities Co., the Gas & Electric Securities Co., and the Cities Service Co. with each other and with 15 other corporations. Individual concerns in this group control an aggregate of 271,752 water horsepower and 552,417 steam horsepower, a total of 824,169 horsepower, or 5.9 per cent of the total of each class of power used in public-service operations.

Electric Bond & Share Co.—Plate 9 shows the relations through common directors or principal officers of the Electric Bond & Share Co. to 41 other corporations. This company is controlled by the General Electric Co. through the ownership of the entire common stock. The aggregate amount of public-service power controlled by the individual concerns shown within this group is 928,486 water horsepower and 1,300,370 steam horsepower, a total of 2,228,856 horsepower, or 20.1 per cent, 13.9 per cent, and 16 per cent, respectively, of the total amount of each class of power employed in public-service uses.

Electric Securities Corporation.—The entire common stock of this company also is owned by the General Electric Co. Plate No. 10 shows the relation between the Electric Securities Corporation and 20 affiliated companies. The amount of power controlled by the individual concerns shown upon this chart aggregates 497,533 water horsepower and 819,045 steam horsepower, a total of 1,316,578 horsepower, or 10.8 per cent, 8.8 per cent, and 9.4 per cent, respectively, of the total amounts in the United States in public-service use.

General Electric Co.—Plate 13 shows the direct connections through common directors or principal officers between the General Electric Co. and 29 affiliated corporations. If there is subtracted from the aggregate controlled by the individual corporations shown upon the chart the amount under the control of the International Paper Co., the connection of which with the General Electric Co. is shown upon the chart, the balance remaining will amount to 703,306 water horsepower and 1,298,514 steam horsepower, a total of 2,001,820 horsepower, or 15.2 per cent, 13.9 per cent, and 14.3 per cent of the respective totals for the United States developed for public-service use.

The number of concerns with which the General Electric Co. is affiliated through common directors or principal officers, either directly or through the medium of the Electrical Securities Corporation and the Electric Bond & Share Co., both of which the General Electric controls through the ownership of the entire common stock, was too great to be shown upon a single chart in the manner employed in this report. Accordingly, separate charts were prepared for the General Electric Co. and its two owned subsidiaries. If the three groups are combined without duplication and the amount controlled by the International Paper Co. is eliminated, the balance, representing the aggregate amount controlled by the individual concerns shown upon plates 9, 10, and 13, the General Electric groups, amounts to 1,290,466 water horsepower and 1,678,658 steam horsepower, a total of 2,978,124 horsepower, or 28 per cent, 18 per cent, and 21.3 per cent, respectively, of the total public-service power in the several classes in the United States.

Electrical Utilities Co.—Plate 11 shows the relationship between the Electrical Utilities Corporation and 35 other corporations. The aggregate amount of power controlled by the individual concerns shown within this group is 867,615 water horsepower and 891,224 steam horsepower, a total of 1,758,839 horsepower, or 18.8 per cent, 9.5 per cent, and 12.6 per cent, respectively, of the totals in each class used in public-service operations.

Federal Utilities (Inc.).—Plate 12 shows the connections through common directors or principal officers of the Federal Utilities (Inc.), Electric Investment Corporation, Republic Railway & Light Co., American Gas & Electric Co., American Power & Light Co., Central States Electric Corporation, and Federal Light & Traction Co. with each other and with 58 other concerns. If the amount of power employed in industrial use is eliminated, the balance controlled by the individual concerns appearing on this chart aggregates 914,646 water horsepower and 1,845,496 steam horsepower, a total of 2,760,142 horsepower, or 19.8 per cent of the total in each class of power employed in public-service operations.

Middle West Utilities Co.—Plate 14 shows the connections through common directors or principal officers of the Middle West Utilities Co., Public Service Corporation of Northern Illinois, and the United Light & Railways Co. with each other and with 25 other corporations. The amount of power controlled by the individual companies appearing on this chart aggregates 480,257 water horsepower and 959,685 steam horsepower, a total of 1,439,942 horsepower, or 10.3 per cent of the totals of the public-service power in each class in the United States.

North American Co.—Plate 15 shows the connections through common directors or principal officers between the North American Co. and its subsidiaries, the Detroit Edison Co., the Electric Co. of Missouri, and the Wisconsin Edison Co., with each other and with 14 other corporations. The aggregate amount of power controlled by the individual concerns shown upon this chart is 499,365 water horsepower and 748,906 steam horsepower, a total of 1,248,271 horsepower, or 10.8 per cent, 8 per cent, and 8.9 per cent, respectively, of the totals for the United States in public-service use.

Stone & Webster Management Association.—Plate 16 shows the relations through directors or principal officers of the Stone & Webster Management Association, the Electric Corporation, and 45 other corporations. The individual concerns shown upon this sheet control an aggregate of 1,353,886 water horsepower and 920,549 steam horsepower, a total of 2,274,435 horsepower, or 29.4 per cent, 9.8 per cent, and 16.3 per cent, respectively, of the totals of each class employed in public-service operations.

United Equities Corporation.—Plate 17 shows the relation through common directors and principal officers which exist between the United Equities Corporation, the United Gas & Electric Corporation, and 47 other concerns. The aggregate amount of power, after deducting industrial power, controlled by the individual concerns shown within this group is 956,474 water horsepower and 1,355,907 steam horsepower, a total of 2,312,381 horsepower, or 20.8 per cent, 14.5 per cent, and 16.6 per cent, respectively, of the totals for the United States as developed for public-service use.

Westinghouse Electric & Manufacturing Co.—Plate 18 shows the relations through common directors and principal officers of the Westinghouse Electric & Man-

ufacturing Co. and the Electric Properties Corporation with each other and with 38 other companies. The aggregate public-service power controlled by the individual concerns appearing within this group is 405,705 water horsepower and 1,989,432 steam power, a total of 2,395,137 horsepower, or 8.8 per cent, 21.3 per cent, and 17.2 per cent, respectively, of the totals for the United States within each class used in public-service operations.

J. G. White & Co. (Inc.).—Plate 19 shows the relations between J. G. White & Co. (Inc.) and J. G. White Management Corporation with 45 other public-service corporations. The total power controlled by the individual concerns shown in this group is 816,683 water horsepower and 1,599,324 steam horsepower, a total of 2,416,007 horsepower, or 17.7 per cent, 17.1 per cent, and 17.3 per cent, respectively, of the totals of public-service power in the United States.

Table No. 3, Part III, gives the names of the 158 corporations which appear upon the several plates to which reference has been made. From this table it will be possible to locate any of the concerns named and to determine the duplication of names on the different charts. As stated earlier, it is not possible to determine the amount of duplication of capitaliza-

tion, either as between individual concerns or for the totals in any one group, since sufficiently detailed information is not available. The totals of power controlled, however, are taken entirely from the detailed sheets for the several States as given in Part II, and it has been possible to eliminate all duplications either within the individual concerns or within the several groups.

RELATION BETWEEN BANKING CORPORATIONS AND ELECTRIC-POWER HOLDING COMPANIES.

On plates 78 to 108, in Part III, are shown the relations which exist between certain banking corporations, chiefly in New York, Boston, and Philadelphia, with certain electric-power holding corporations, due to the fact that directors in the banking corporations are also directors or principal officers in the electric-power holding companies. No attempt has been made to determine the amount of power under the control of the groups of power corporations with which the several banking corporations are affiliated. The plates are inserted merely to indicate the extent to which certain banking corporations are interested in electric-power corporations, or vice versa.

CONTROL OF UNDEVELOPED WATER POWER.

In connection with the other studies made for this report considerable information was collected concerning the amount of undeveloped power reported to be in the ownership or control of public-service corporations. Time has not been available for verifying the data or for determining whether or to what degree such undeveloped water powers are claimed by those interests which control the majority of the developed powers. The data show, however, that 120 out of about 1,500 public-service corporations, the developments of which have been listed in this report, claim to own or control a total of 3,683,000 undeveloped water horsepower, or 80 per cent of the total water power at present developed by public-service corporations.

Whether or not these figures are wholly reliable, it may be pertinent to remark that those who lay claim to such extensive ownership or control of undeveloped power sites are hardly in a position to contend that any legislation or lack of legislation or any administrative policies of the executive departments of the Government should be held responsible for the stagnation in water-power development which they allege exists. The fact, if it is a fact, that a comparatively few corporations hold unused nearly 4,000,000 water horsepower would of itself furnish sufficient explanation.

Ownership or control of undeveloped water powers, even to the extent claimed by these corporations, is not the most effective method of securing control of the business. If, as is probably the case, the sites owned are those most immediately valuable and best suited for early development, then those who own or

control them hold the initial advantage; but the chief factor in control is not so much the ownership of undeveloped power sites as it is the domination of the market. An enterprise once started and with its market established occupies a position of such distinct advantage that it can finance and extend its developments upon terms that a new and untried enterprise can not secure. The proportion of entirely new enterprises will, for this reason, grow progressively less. This tendency is being further augmented by the attitude of public-utility commissions which are increasingly manifesting a disposition to favor the extension of established enterprises into new territory rather than the development of such territory by new and competitive enterprises. No other State has had such a remarkable water-power development as California within the last few years. Hundreds of thousands of horsepower have been developed and hundreds of millions of dollars have been invested in the electric-power business. Yet a most careful investigation could not discover that a single new public-utility enterprise involving the development of water power had been started in that State within the last six years. The remarkable development which has taken place consists entirely in extensions to the business of concerns already in the field. Great concentration of power development under present conditions will depend only in a minor degree upon control of undeveloped sources of power; the determining factors will be control of the markets and control of the sources of credit.

